



TECH BRIEFS

ENGINEERING SOLUTIONS FOR DESIGN & MANUFACTURING

**Chemical
Sensors Provide
"Optical Nose"**

**Virtual Reality &
Engineering: Changing
the Way We Design**

Photonics Tech Briefs

Motion Control Tech Briefs

REFERENCE

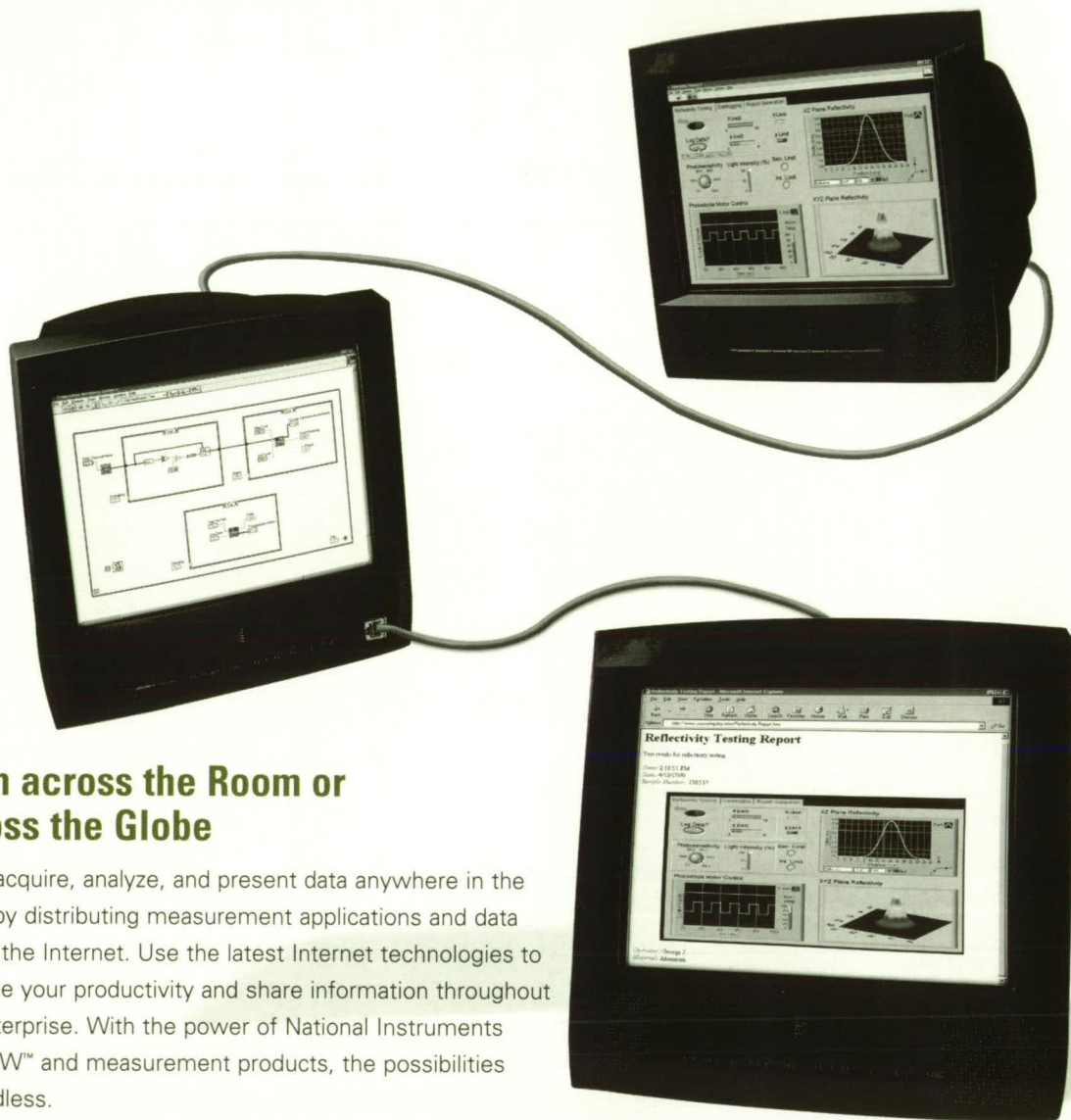
**COPY JUN 12 REC'D
KSC LIBRARY**



www.nasatech.com

PERIODICALS
*****3-DIGIT 328
#00003764545NB5# 0102 17 265
LOU OFFNER LIBRARIAN
IDI
LIBRARY C
KENNEDY SPACE CENTER FL 32899-0001
P 2

Acquire. Analyze. Present.



From across the Room or across the Globe

Easily acquire, analyze, and present data anywhere in the world by distributing measurement applications and data across the Internet. Use the latest Internet technologies to increase your productivity and share information throughout the enterprise. With the power of National Instruments LabVIEW™ and measurement products, the possibilities are endless.

Discover for Yourself the Power of LabVIEW 6i.

ni.com/info

For more information or a FREE LabVIEW Evaluation CD, visit ni.com/info and enter namk05.

For More Information Circle No. 508

 **NATIONAL
INSTRUMENTS™**

(800) 776-8662

Fax: (512) 683-9300 • info@ni.com

Shop Online for Infrared Pyrometers!

OMEGASCOPE®

Laser Circle/Dot Sighting

- ✓ ±1% Accuracy
- ✓ Thermocouple Input
- ✓ RS-232 Communication
- ✓ -18 to 540°C (0-1000°F)
- ✓ ac or Battery Power



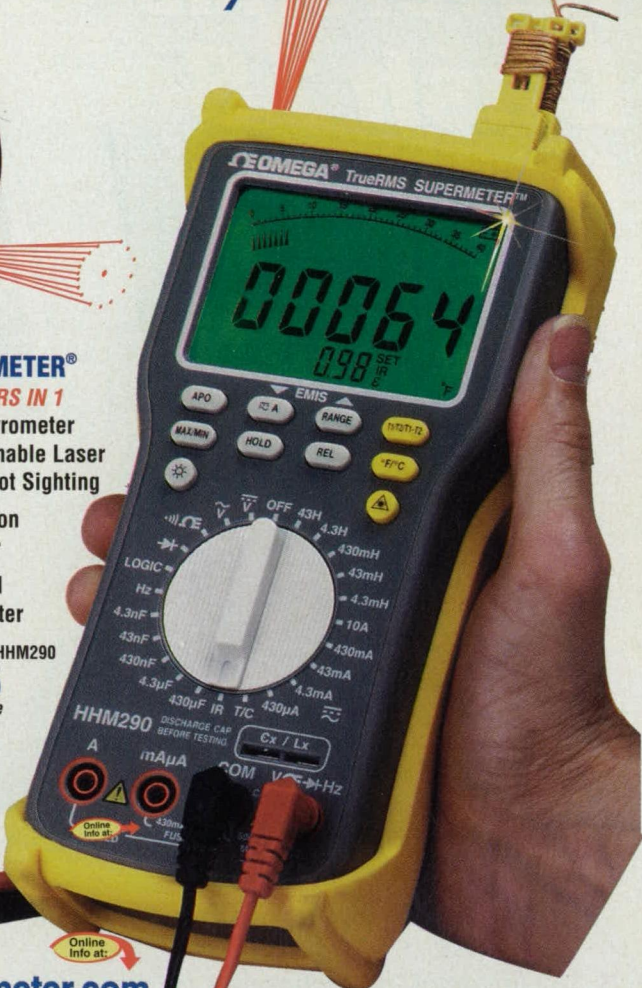
SUPERMETER®

3 METERS IN 1

- ✓ Infrared Pyrometer with Switchable Laser Circle or Dot Sighting
- ✓ Full Function Multimeter
- ✓ Differential Thermometer

SUPERMETER® HHM290

\$345
Complete



OMEGASCOPE®
SERIES
\$295
Basic Unit

Circle No. 502

isupermeter.com

Online
Info at:
[omegascope.net](http://www.omegascope.net)

Circle No. 501

Model OS533 Shown
\$895
Probe and Tripod
Not Included

U.S. and
Foreign Patents
and Patents
Pending

www.omega.com
e-mail: info@omega.com



To Request Your
DILBERT® Deck Card Pack,
Dial: 1-(203)-329-1266

Get Your Dilbert Card Deck Circle No. 504

DILBERT® by Scott Adams

THE FIVE HUNDRED
DOLLAR MORALE
IMPROVEMENT
AWARD GOES TO ED.



DILBERT © United Feature Syndicate, Inc.

GAA!! IT'S
ONLY \$240
AFTER TAXES!!!



www.dilbert.com

SO THAT'S
WHAT
GOOD MORALE
LOOKS
LIKE.



DILBERT © 2000 United Feature Syndicate, Inc.

omega.com/dilbert Dilbert Decks No. 10 & 11 Available

Find These Products 3 Ways!

- 1 Internet
- 2 Hard Covered Handbooks
- 3 CD-ROM

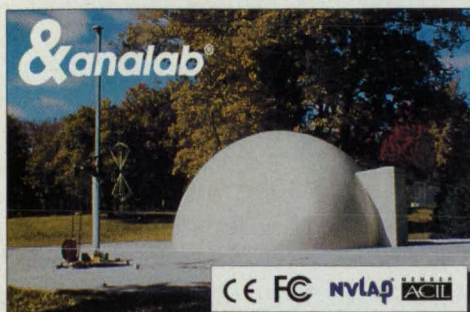


For Product
Literature Visit
Our Website or

Circle No. 503

Now!

EMC and FCC Compliance Testing Services BY OUR AFFILIATE — SERVICE BEYOND THE HANDBOOK™



- ✓ ENV50204:1995 Radiated 900 MHz Pulsed RF
- ✓ Emissions Testing to CISPR 11, 14, 22
- ✓ Immunity Testing to IEC1000-4
- ✓ FCC Part 15, EN61000-3-2, 3

For Fast Compliance
Testing Services Call:

1-800-262522-9
1-800-analab-x

Online
Info at:

www.analab1.com
e-mail: info@analab1.com

Circle No. 505

ORDER ONLINE!

Over 100,000 Process
Control Products Online!

omega.com®

Ω OMEGA®

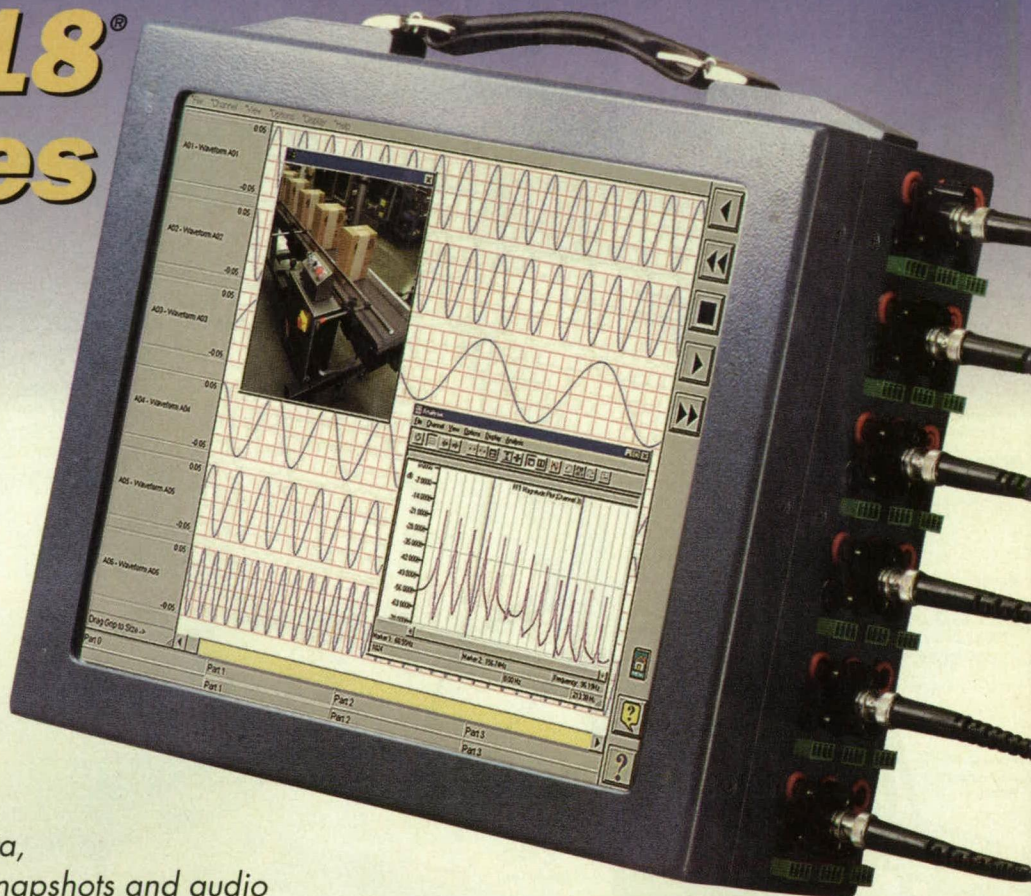
1-888-82-66342SM
1-888-TC-OMEGA



e-mail: info@omega.com

©COPYRIGHT 2001 OMEGA ENGINEERING, INC. ALL RIGHTS RESERVED.

What do you need to record ? Waveforms – Video – Audio... **Dash 18[®]** handles it all!

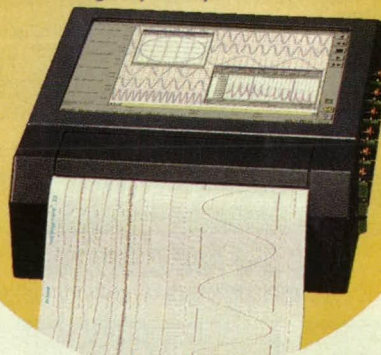


- Record waveform data, synchronized video snapshots and audio
- 18 Universal input channels for voltage, thermocouple and bridge
- 15.4" touch-screen display for data viewing and analysis
- Record data directly to 9 GB hard drive at 100 kHz per channel
- Real-time filtering and math functions
- 10/100 BaseT Ethernet interface and 250 MB Zip drive



Optional Printer

For real-time recording or playback from memory, an attachable 10" wide high speed printer is available.



Call, E-mail, Fax, or write to us today for all the details. Web Site: www.astro-med.com/de16



Astro-Med, Inc.

TEST & MEASUREMENT PRODUCT GROUP

Astro-Med is System Certified to ISO-9001

Astro-Med Industrial Park, West Warwick, Rhode Island 02893

Phone: (401) 828-4000 • Toll Free: 1-877-867-9783 • Fax: (401) 822-2430

In Canada Telephone 1-800-565-2216 • E-mail: mtgroup@astromed.com

For More Information Circle No. 525

TRIFECTA!



www.
Digi-Key®
.com

1-800-DIGI-KEY
www.digikey.com

For More Information Circle No. 516

© 2001 Digi-Key Corporation

The distributor Internet site most frequently visited by respondents in the Distributor Evaluation Study, Beacon Technology, October 2000.
The distributor with the highest rating for Delivery of Product in the Distributor Evaluation Study, Beacon Technology, October 2000.
The distributor with the highest rating for Availability of Product in the Distributor Evaluation Study, Beacon Technology, October 2000.



Microsoft
Project 2000 
Microsoft Office Application



If deadlines weren't important, they wouldn't begin with "dead."

It looms there, the deadline. And no one feels the pressure of it like the project manager. And while you may never be able to completely eradicate that knot in your stomach, you can certainly loosen it, because Microsoft® Project 2000 will help you navigate the complexities of managing projects in this frenetic business environment. It's filled with flexible tools for scheduling, organizing, analyzing, and reviewing complex projects. And it's optimized with features that automatically update information, manage and allocate resources, and let users work collaboratively across an organization. Suddenly deadlines don't seem so deadly. To find out more, visit microsoft.com/project or go to Internet Keyword: Microsoft Project. **Software for the Agile Business.**

For More Information Circle No. 520

Microsoft®



FEATURES

- 16 Alternative Engineering: How Virtual Reality and Simulation are Changing Design and Analysis**
- 32 Application Briefs**

SOLUTIONS

- 33 Special Coverage: Sensors**
 - 33 Fiber-Optic Transducers for Distributed Sensing of Volatiles: An Optical Nose
 - 34 Pressure Sensor Based on Measurement of Vibration Damping
 - 35 Integrated Capacitive Wheel-Contact Sensors
 - 36 Rare-Earth Optical Temperature Sensors
 - 38 Microelectromechanical Sensors Based on Magnetoresistance
 - 39 Capacitive Sensor for Measuring Level of Liquid Nitrogen
 - 40 Black Jack GPS Receiver

- 42 Electronic Components and Systems**
 - 42 Digitally Programmable Analog Membership-Function Circuits
 - 44 Regenerative Pseudonoise Ranging
 - 46 Biomorphic Analog Pulse-Coupled Neural Circuits
 - 49 Weighing Scales Based on Low-Power Strain-Gauge Circuits

- 50 Software**
 - 50 Generating Maps of the Ionosphere From GPS Measurements
 - 50 Program for Simulating Rotor Dynamics on Personal Computers
 - 50 Software for Monitoring and Controlling DSN Operations

- 52 Materials**
 - 52 Lithium Alkoxide Electrolyte Additives for Lithium-Ion Cells
 - 53 Aliphatic Ester Electrolyte Additives for Lithium-Ion Cells
 - 53 Ethyl Methyl Carbonate as a Cosolvent for Lithium-Ion Cells
 - 54 Rechargeable Li-Ion Cells Containing TiS_2 Anodes
 - 56 Filled Skutterudites as Thermoelectric Materials



16

32



68

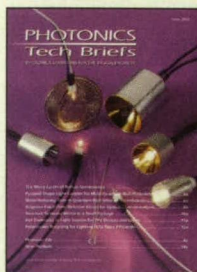
DEPARTMENTS

- 12 Commercial Technology Team**
- 14 UpFront**
- 26 Reader Forum**
- 28 Who's Who at NASA**
- 29 Technologies of the Month**
- 30 Commercialization Opportunities**
- 71 Advertisers Index**

NEW FOR DESIGN ENGINEERS

- 66 Web Sites**
- 67 Software**
- 68 Products**
- 70 Literature**

SPECIAL SUPPLEMENTS



1a - 14a Photonics Tech Briefs

Follows page 24 in selected editions only.

**Motion
CONTROL
Tech Briefs**

1b - 8b

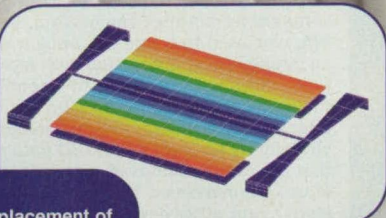
Motion Control Tech Briefs

Follows page 64 in selected editions only.

ALGOR SIMULATES MEMS

Visit simulatemems.algor.com

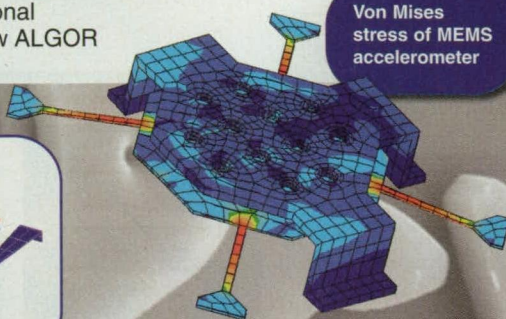
and watch our free educational Webcast demonstrating how ALGOR software simulates MEMS.



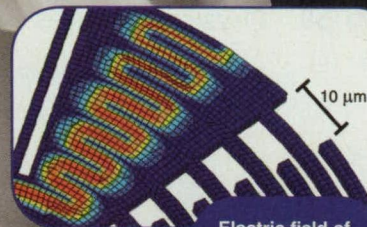
Displacement of MEMS switch



MEMS switch compared to a penny



Von Mises stress of MEMS accelerometer



Electric field of MEMS radial comb motor

ALGOR's direct-selling and high-technology business model delivers the best FEA-based simulation value for MEMS simulation in the CAE industry. ALGOR's MEMS solution links electrostatic analysis to structural analysis tools with an easy-to-use graphical user interface that works within many popular CAD systems and includes a precision FEA model building tool.

ALGOR'S MEMS SOLUTION INCLUDES:

- Multiphysics analysis software to simulate the real-world mechanical behavior for several physical factors acting simultaneously, such as:
 - Electrostatic analysis software that calculates forces due to surface charges
 - Mechanical Event Simulation for virtual replication of dynamic events with linear and nonlinear material models that predicts electromechanical effects driven by electrostatic forces
 - Structural analysis software that predicts electromechanical effects driven by electrostatic forces
 - Piezoelectric material models for Mechanical Event Simulation and static stress analysis
 - Composite material models for Mechanical Event Simulation and static stress analysis
 - Thermal analysis for considering the effects of heat transfer
 - Fluid flow analysis for considering the effects of fluid dynamics
- An easy-to-use graphical user interface that enables engineers to directly apply electrostatic forces to a structural model and provides right-click functionality for applying, modifying and removing loads, constraints and finite element properties
- Built-in precision FEA model building capabilities with geometric scaling and structured meshing capabilities
- InCAD technology for CAD/CAE interoperability within Autodesk Inventor, CADKEY, Mechanical Desktop, Pro/ENGINEER for Windows, Solid Edge and SolidWorks
- Unstructured brick and tetrahedral meshing
- A midplane mesh engine that automatically converts thin solid parts into plate/shell elements
- A Material Library Manager that controls material property data for all analysis types

WHAT ARE MEMS?

Micro Electro Mechanical Systems (MEMS) are micromachines the size of a grain of salt or the eye of a needle that integrate mechanical elements, sensors, actuators and electronics on a common silicon substrate. MEMS applications include optical switches within telecommunication and networking systems, accelerometers in automotive airbags, inkjets in desktop printers and sensors in medical testing equipment. The emerging MEMS industry promises to make the next generation of electronic products smarter and cheaper.

ALGOR
When Engineering Has to be Right

150 Beta Drive
Pittsburgh, PA 15238-2932 USA
US Phone: 1.412.967.2700
Fax: 1.412.967.2781
Europe (UK): 44.1784.442.246
California: 1.714.564.0844
E-mail: simulatemems@algor.com
simulatemems.algor.com



SOLID EDGE

PREMIUM
VOYAGER
MEMBER



Autodesk
Registered Developer

57 Manufacturing/Fabrication

- 57 Expendable Composite-Layup Dies From Rapid-Prototype Masters
- 58 Punches and Dies for Rounding Corners of Metal Sheets

59 Physical Sciences

- 59 Model of Pyrolysis of Biomass in a Fluidized-Bed Reactor
- 60 System for Delivering Gas Samples to Multiple Instruments
- 61 Atmospheric Source of Atomic Oxygen for Cleaning Paintings

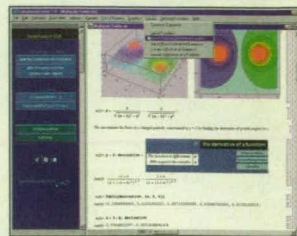
65 Information Sciences

- 65 General-Purpose Wavelet Program
- 65 Automated Generation of Reports of Mars Rover Operations

This document was prepared under the sponsorship of the National Aeronautics and Space Administration. Neither Associated Business Publications Co., Ltd. nor the United States Government nor any person acting on behalf of the United States Government assumes any liability resulting from the use of the information contained in this document, or warrants that such use will be free from privately owned rights. The U.S. Government does not endorse any commercial product, process, or activity identified in this publication.

PRODUCT OF THE MONTH

CalculationCenter midmarket technical calculation software from Wolfram Research, Champaign, IL, combines algebraic operations with numerics, graphics, and a technical word processor.



14

ON THE COVER



Tecplot® version 9.0 technical plotting software from Amtec Engineering, Bellevue, WA, was used to create this visualization of an impinging jet interacting with a cross flow. Through the addition of OpenGL®, the new version of the software lets users interactively visualize, explore, analyze, and virtually fly through 2D and 3D data sets that consist of millions of data points. For more information on Tecplot 9.0, and to learn about other new software packages, see New on Disk on page 67.

(Data and visualization courtesy of Amtec Engineering)

Permissions: Authorization to photocopy items for internal or personal use, or the internal or personal use of specific clients, is granted by Associated Business Publications, provided that the flat fee of \$3.00 per copy be paid directly to the Copyright Clearance Center (222 Rose Wood Dr., Danvers, MA 01923). For those organizations that have been granted a photocopy license by CCC, a separate system of payment has been arranged. The fee code for users of the Transactional Reporting Service is: ISSN 0145-319X/94 \$3.00+ .00

If it's vibration, pressure or shock, we measure it.



Signal Conditioner for Piezoelectric/ISOTRON® Sensors - Model 133

- Multi-Purpose 3-Channel Signal Conditioner
- Selectable Filter Options
- 100 kHz Bandwidth
- RS-232 Serial Interface
- Excellent Value



Actual Size

10mm-Cube Triaxial Accelerometer - Model 65

- Measures in all 3 axes
- Sensitivity 10 or 100 mV/g
- Lightweight 5 gm
- 10 kHz Frequency Response
- Single Output Cable

Endevco's products are used throughout the world - in aerospace, defense, automotive, test laboratories and jet engine test cells. We have signal conditioning to meet the needs of bench-top, single channel, multi-channel computer controlled and even the newest technology of the IEEE-1451.4 Smart Sensors. So if you've got a challenge, call the dedicated people of Endevco.

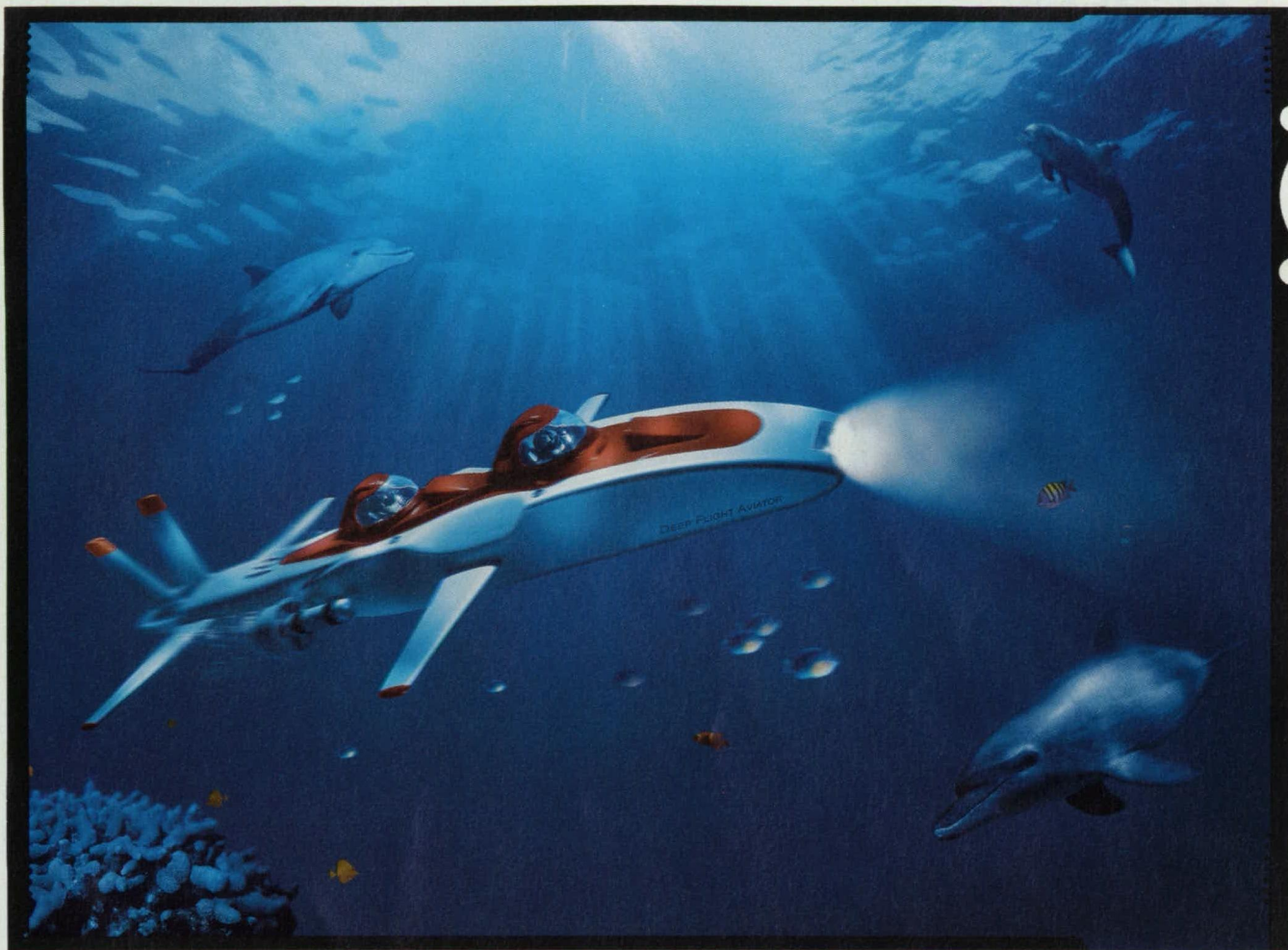
MEGGITT

WHAT CAN WE DO FOR YOU TODAY?

ENDEVCO 

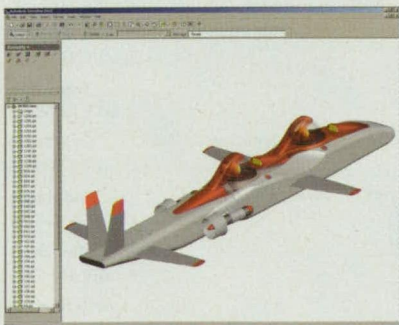
San Juan Capistrano, CA
www.endevco.com/4c2t
applications@endevco.com
800/982-6732 • 949/661-7231 fax

*AUTODESK INVENTOR GETS YOU FROM 2D TO 3D DESIGN.
WHERE YOU GO FROM THERE IS UP TO YOU.*



Deep Flight Aviator was invented and designed by Graham Hawkes of Hawkes Ocean Technologies using Autodesk Inventor software. To learn more, visit www.autodesk.com/nolimits.

View the online demo to see how Autodesk Inventor™ makes the transition from 2D to 3D painless.



Suddenly, you have the tools to take your ideas where they've never gone before. In fact, Autodesk Inventor is so easy to use, you'll be productive from day one. Built around our powerful adaptive technology, Autodesk Inventor delivers the industry's first completely new 3D design technology in over a decade. With industry-leading DWG compatibility, Web-based collaboration, and exceptional large-assembly performance, Autodesk Inventor brings you the freedom you need to design without limits. Ready to dive in? Visit www.autodesk.com/sub and view the online demo today.

autodesk®



MULTIPLE COMPUTER & VIDEO SIGNALS ON A SINGLE SCREEN



SUPERVIEW™. . . FOR MAXIMUM FLEXIBILITY

Up to 10 computer and/or
video inputs

Independent scale, position & zoom
for each input

Overall system resolution up to
1600 x 1200

Inputs up to 1280 x 1024

Computer on video overlays

Control software
for Windows 95/98/NT



QUADVIEW™. . . THE LOWER COST ALTERNATIVE

4 computer and video inputs

Full screen and quad mode

Graphics inputs to 1280 x 1024

Output to 1280 x 1024

Optional DVI digital output

Visit our web site www.rgb.com

RGB SPECTRUM®
a visual communications company™

950 Marina Village Parkway
Alameda, California 94501
Tel: (510) 814-7000
Fax: (510) 814-7026
E-mail: sales@rgb.com



TECH BRIEFS
www.nasatech.com



Published by Associated Business Publications
Publisher Joseph T. Pramberger
Editor/Associate Publisher Linda L. Bell
Editor, Market Focus Editions Robert Clark
Senior Editor/Internet Editor Jason C. Flynn
Production Manager Margery Koen
Assistant Production Manager John Iwanciw
Art Director Lois Erlacher
Senior Designer Christopher Coleman
Circulation Manager Hugh J. Dowling

BRIEFS & SUPPORTING LITERATURE: Written and produced for NASA by
Advanced Testing Technologies, Inc., Hauppauge, NY 11788

Technical/Managing Editor Ted Selinsky
Sr. Technical Analyst Dr. Larry Grunberger
Art Manager Eric Starstrom
Staff Writers/Editors Dr. Theron Cole, George Watson
Graphics Robert Simons
Editorial & Production Joan Schmiemann, Becky D. Bentley

NASA:

NASA Tech Briefs are provided by the National Aeronautics and Space
Administration, Technology Transfer Division, Washington, DC:

Administrator Daniel S. Goldin
Director, Commercial Technology Dr. Robert Norwood
Publications Director Carl Ray

ASSOCIATED BUSINESS PUBLICATIONS INTERNATIONAL

317 Madison Avenue, New York, NY 10017-5391
(212) 490-3999 FAX (212) 986-7864

Chairman/Chief Executive Officer Bill Schnirring (bill@abpi.net)
Vice Chairman/Chief Operating Officer Domenic A. Mucchetti
MIS Manager Ted Morawski
Webmaster Albert Sunseri
eStrategy Director Andrew Runk
Credit/Collection Felecia Lahey
Human Resources Manager Lourdes Del Valle
Accounting Manager Sylvia Ruiz
Office Manager Alfredo Vasquez

NASA TECH BRIEFS ADVERTISING ACCOUNT EXECUTIVES

Headquarters (212) 490-3999
CT, MA, NH, ME, VT, RI, Eastern Canada Ed Marecki
at (401) 351-0274
NJ, NY, PA, DE Jim Oot
at (973) 316-9695
VA, MD, DC, NC, SC, GA, FL, AL, TN, MS, LA, AR, OK, TX Bill Manning
at (770) 971-0677
MN, ND, SD, WI, IL Bob Casey
at (847) 223-5225
IN, KY, MI, OH, MO, KS, IA, NE, Western PA & NY, Central Canada Chris Casey
at (847) 223-5225
N. Calif., CO, WA, OR, ID, MT, WY, UT, Western Canada Bill Hague
at (800) 830-4351
S. Calif., AZ, NM, NV Tom Boris
at (949) 642-2785
Internet Advertising Luke Schnirring
at (212) 490-3999
TechDeck Postcard Advertising John Waddell
at (212) 490-3999

**For a complete list of staff e-mail addresses,
visit www.abpi.net**

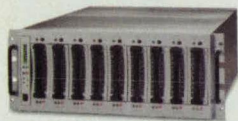
1 RAID Controller Module
+
8 Storage Enclosures
=
A Cluster of Mass Storage

infoStation™

THE ONLY POSSIBLE WAY

DO THE MATH AND YOU'LL REALIZE THAT INFOSTATION™ is the only mass storage enclosure available today with onboard capability that allows your customers to grow a 60 drive RAID array, *without* having to incur additional controller costs!

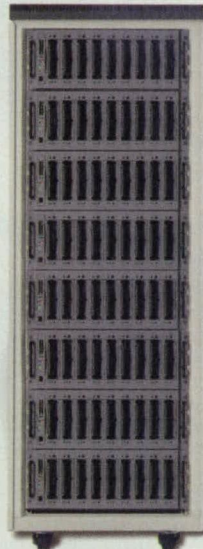
InfoStation's RAID Controller Module is capable of over 18,000 IOPS, includes 128 MB of cache memory and supports RAID levels 0 through 10. (1) feature-rich Fibre to SCSI RAID Controller Module supports up to (8) InfoStations, 60 drives. The SCSI to SCSI version supports up to (4) InfoStations, 30 drives.



InfoStation, the intelligent 9-bay RAID-ready backplane enclosure, supports up to (4) hosts. InfoStation is self-monitoring with a scrolling

user interface and alarm. Also included are field-upgradable SAF-TE, NAS and SES upgrade slots. This enclosure is perfect for RAID array clustering or cascading applications.

StorCase is so confident that you and your customers will be completely happy with InfoStation that we are offering a 30-day, **no questions asked**, money-back trial period. Call one of our well-informed consultants today at (800) 337-8421 and find out how growing a storage RAID array with InfoStation will add up to substantial long-term savings for your customers.



TAKE THE VIRTUAL
INFOSTATION TOUR

www.storcase.com/tour

StorCase™
TECHNOLOGY
A Kingston Technology Company

INGRAM
MICRO

D&H

GATES/ARROW
DISTRIBUTING

ds

Tech Data

SYNNEX

BELL MICROPRODUCTS

CONSAN
A GATES/ARROW Company



© 2001 StorCase Technology, Inc. A Kingston Technology Company. 17600 Newhope Street, Fountain Valley, CA 92708 USA (714) 438-1850 Fax (714) 438-1847. All rights reserved. All registered trademarks and trademarks are the property of their respective owners.

For More Information Circle No. 546

NASA Commercial Technology Team

NASA's R&D efforts provide a robust supply of promising technologies with applications in many industries. A key mechanism in identifying commercial applications for this technology is NASA's national network of commercial technology organizations. The network includes ten NASA field centers, six Regional Technology Transfer Centers (RTTCs), the National Technology Transfer Center (NTTC), business support organizations, and a full tie-in with the Federal Laboratory Consortium (FLC) for Technology Transfer. Call (609) 667-7737 for the FLC coordinator in your area.

NASA's Technology Sources

If you need further information about new technologies presented in NASA Tech Briefs, request the Technical Support Package (TSP) indicated at the end of the brief. If a TSP is not available, the Commercial Technology Office at the NASA field center that sponsored the research can provide you with additional information and, if applicable, refer you to the innovator(s). These centers are the source of all NASA-developed technology.

Ames Research Center

Selected technological strengths: Information Technology; Biotechnology; Nanotechnology; Aerospace Operations Systems; Rotorcraft; Thermal Protection Systems.
Carolina Blake
(650) 604-1754
cblake@mail.arc.nasa.gov

Dryden Flight Research Center

Selected technological strengths: Aerodynamics; Aeronautics Flight Testing; Aeropropulsion; Flight Systems; Thermal Testing; Integrated Systems Test and Validation.
Jenny Baer-Riedhart
(661) 276-3689
jenny.baer-riedhart@dfrc.nasa.gov

Goddard Space Flight Center

Selected technological strengths: Earth and Planetary Science Missions; LIDAR; Cryogenic Systems; Tracking; Telemetry; Remote Sensing; Command.
George Alcorn
(301) 286-5810
galcorn@gsc.nasa.gov

Jet Propulsion Laboratory

Selected technological strengths: Near/Deep-Space Mission Engineering; Microspacecraft; Space Communications; Systems; Remote Sensing; Robotics.
Merle McKenzie
(818) 354-2577
merle.mckenzie@jpl.nasa.gov

Johnson Space Center

Selected technological strengths: Artificial Intelligence and Human Computer Interface; Life Sciences; Human Space Flight Operations; Avionics; Sensors; Communications.
Charlene E. Gilbert
(281) 483-0474
charlene.e.gilbert1@jsc.nasa.gov

Kennedy Space Center

Selected technological strengths: Fluids and Fluid Systems; Materials Evaluation; Process Engineering; Command, Control and Monitor Systems; Range Systems; Environmental Engineering and Management.
Jim Aliberti
(321) 867-6224
Jim.Aliberti-1@ksc.nasa.gov

Langley Research Center

Selected technological strengths: Aerodynamics; Flight Systems; Materials; Structures; Sensors; Measurements; Information Sciences.
Sam Morello
(757) 864-6005
s.a.morello@larc.nasa.gov

John H. Glenn Research Center at Lewis Field

Selected technological strengths: Aeropropulsion; Communications; Energy Technology; High Temperature Materials Research.
Larry Viterna
(216) 433-3484
cto@grc.nasa.gov

Marshall Space Flight Center

Selected technological strengths: Materials; Manufacturing; Nondestructive Evaluation; Biotechnology; Space Propulsion; Controls and Dynamics; Structures; Microgravity Processing.
Vernotto McMillan
(256) 544-2615
vernotto.mcmillan@msfc.nasa.gov

Stennis Space Center

Selected technological strengths: Propulsion Systems; Test/Monitoring; Remote Sensing; Nonintrusive Instrumentation.
Kirk Sharp
(228) 688-1929
kirk.sharp@ssc.nasa.gov

NASA Program Offices

At NASA Headquarters there are seven major program offices that develop and oversee technology projects of potential interest to industry. The street address for these strategic business units is: NASA Headquarters, 300 E St. SW, Washington, DC 20546.

Carl Ray
Small Business Innovation Research Program (SBIR) & Small Business Technology Transfer Program (STTR)
(202) 358-4652
cray@mail.hq.nasa.gov

Dr. Robert Norwood
Office of Commercial Technology (Code RW)
(202) 358-2320
norwood@mail.hq.nasa.gov

John Mankins
Office of Space Flight (Code MP)
(202) 358-4659
jmankins@mail.hq.nasa.gov

Terry Hertz
Office of Aero-Space Technology (Code RS)
(202) 358-4636
thertz@mail.hq.nasa.gov

Glen Mucklow
Office of Space Sciences (Code SM)
(202) 358-2235
gmucklow@mail.hq.nasa.gov

Roger Crouch
Office of Microgravity Science Applications (Code U)
(202) 358-0689
rcrouch@hq.nasa.gov

Granville Paules
Office of Mission to Planet Earth (Code Y)
(202) 358-0706
gpaules@mtpe.hq.nasa.gov

NASA's Business Facilitators

NASA has established several organizations whose objectives are to establish joint sponsored research agreements and incubate small start-up companies with significant business promise.

Wayne P. Zeman
Lewis Incubator for Technology
Cleveland, OH
(216) 586-3888

Thomas G. Rainey
NASA KSC Business Incubation Center
Titusville, FL
(407) 383-5200

B. Greg Hinkebein
Mississippi Enterprise for Technology
Stennis Space Center, MS
(800) 746-4699

Joanne W. Randolph
BizTech
Huntsville, AL
(256) 704-6000

Julie Holland
NASA Commercialization Center
Pomona, CA
(909) 869-4477

Joe Becker
Ames Technology Commercialization Center
San Jose, CA
(408) 557-6700

Bridgette Smalley
UH-NASA Technology Commercialization Incubator
Houston, TX
(713) 743-9155

Marty Kaszubowski
Hampton Roads Technology Incubator (Langley Research Center)
Hampton, VA
(757) 865-2140

John Fini
Goddard Space Flight Center Incubator
Baltimore, MD
(410) 327-9150 x1034

NASA-Sponsored Commercial Technology Organizations

These organizations were established to provide rapid access to NASA and other federal R&D and foster collaboration between public and private sector organizations. They also can direct you to the appropriate point of contact within the Federal Laboratory Consortium. To reach the Regional Technology Transfer Center nearest you, call (800) 472-6785.

Joseph Allen
National Technology Transfer Center
(800) 678-6882

Dr. William Gasko
Center for Technology Commercialization
Massachusetts Technology Park
(508) 870-0042

Gary Sera
Mid-Continent Technology Transfer Center
Texas A&M University
(409) 845-8762

Chris Coburn
Great Lakes Industrial Technology Transfer Center
Battelle Memorial Institute
(440) 734-0094

Ken Dozier
Far-West Technology Transfer Center
University of Southern California
(213) 743-2353

J. Ronald Thornton
Southern Technology Applications Center
University of Florida
(352) 294-7822

Lani S. Hummel
Mid-Atlantic Technology Applications Center
University of Pittsburgh
(412) 383-2500

NASA ON-LINE: Go to NASA's Commercial Technology Network (CTN) on the World Wide Web at <http://nctn.hq.nasa.gov> to search NASA technology resources, find commercialization opportunities, and learn about NASA's national network of programs, organizations, and services dedicated to technology transfer and commercialization.

If you are interested in information, applications, and services relating to satellite and aerial data for Earth resources, contact: Dr. Stan Morain, **Earth Analysis Center**, (505) 277-3622.

New Version!

Tecplot 9.0

Enjoy the View™

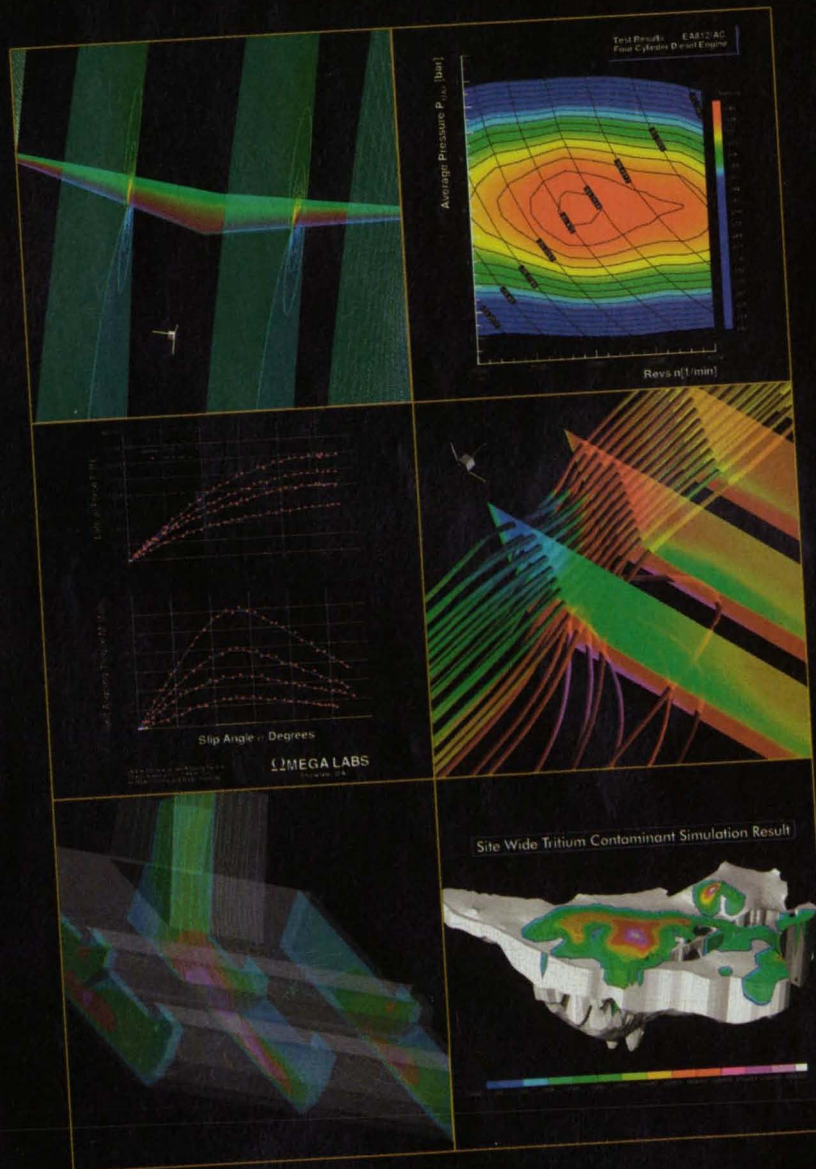
When you're scaling a mountain of data you want to see the most informative views — the ones that show the trends, the anomalies and the physics in your data.

The next time you embark on an engineering project — be it simulation, analysis or experiment — count on Tecplot, the data plotting and visualization software that gives you full control over 2-D and 3-D plot parameters.

Conquer your mountains of data with Tecplot and when you reach the top — Enjoy the View.

Experience the view firsthand with a free trial version of Tecplot 9.0 from www.amtec.com/trial. With the scorching speed, brilliant graphics and robust 3-D of the new Tecplot, you might even say the view is breathtaking.

For complete technical information and a list of new capabilities, please call us toll free at **1-800-763-7022** or send e-mail to info@amtec.com



www.amtec.com

tel 425.653.1200 • fax 425.653.9200 • e-mail info@amtec.com

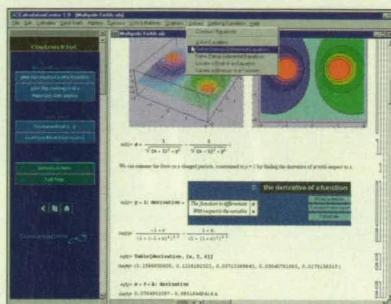
AMTEC

© 2001 Amtec Engineering, Inc. All rights reserved. Tecplot and the Amtec logo are trademarks of Amtec Engineering, Inc. Boston, MA, USA.

Circle No. 543

PRODUCT OF THE MONTH

Wolfram Research, Champaign, IL, has introduced CalculationCenter midmarket technical calculation software that combines algebraic operations with numerics, graphics, and a technical word processor. The program's easy-to-use environment features InstantCalculators that guide users through each step of a calculation and remain in the document for repeated use. Smart plotting selects the range of a plot and the plot type, and works whether input is data or functions. Traditional math input automatically interprets standard math notation, using heuristics to resolve ambiguous input. Input correction automatically suggests which function a user meant to enter if the software cannot match the input. The software produces technical reports that can be distributed via hard copy, e-mail, or the Web, and is available for Windows and Mac OS platforms.



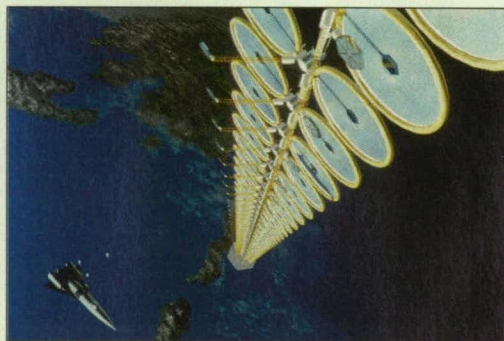
For More Information Circle No. 750

Power Struggle

The energy crisis on the West Coast is bad — and it probably will get worse as we get further into the summer. Limited power consumption and rolling blackouts are making life miserable for many Californians. With the world's population projected to rise to 10 billion people by the year 2050, supplying inexpensive, environmentally friendly electricity will be quite a challenge.

"We need new sources of electrical power," said John Mankins, manager of advanced concepts studies at NASA Headquarters' Office of Space Flight. "We've been studying a variety of space solar power concepts." Space solar power systems use the conversion of sunlight to electricity by beans of photovoltaic (PV) cells. Giant structures consisting of rows of PV arrays could be placed either in a geostationary Earth orbit or on the Moon. The system would collect solar energy in space, convert it to microwaves, and transmit the microwave radiation to Earth, where it would be captured by a ground antenna and transformed into electricity.

According to Dr. Neville Marzwell, technical manager of the Advanced Concepts & Technology Innovations program at NASA's Jet Propulsion



It would be possible to provide the Earth or a moon base with harnessed solar power, or travel in space without returning to Earth for fuel using a space-based solar power generator such as this SunTower. (Photo courtesy of NASA)

Laboratory, "We now have the technology to convert the Sun's energy at the rate of 42 to 56 percent. If you can concentrate the Sun's rays through the use of large mirrors or lenses, you get more for your money because most of the cost is in the PV arrays."

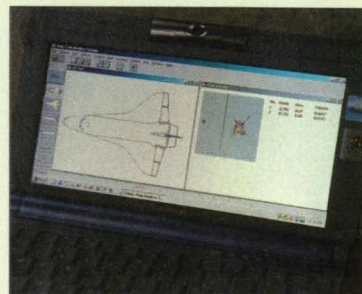
Space-based solar power offers energy from an unending source with no emissions and very little environmental impact. "You don't need cables, pipes, gas, or copper wires. We can send it to you like a cell phone call — where you want it and when you want it, in real time," said Marzwell.

For more information, visit NASA's Marshall Space Flight Center's Science@NASA Web site at <http://science.nasa.gov>.

Hot Stuff

The Space Shuttle's thermal tiles protect the orbiter and its crew from temperatures ranging from -250 to +3000°F during re-entry. After each flight, each one of the 24,000 tiles must be inspected. Engineers from NASA's Ames Research Center in Moffett Field, CA, and the Boeing Co. in Huntington Beach, CA, have developed a handheld laser scanner for inspecting the tiles.

The scanner uses a digital camera and lasers in a measurement technique called laser triangulation. It is the first step toward developing an Electronic Inspection and Mapping System (EIMS) that could aid evaluation of the shuttle's Thermal Protection System (TPS). The 5 x 9" box, when placed over a tile, measures flaws within a 3 x 3" area. The scanner sends the data to a laptop computer. Software locates and characterizes the damage and generates a



3D image that indicates the depth and size of the flaw. The system also contains a database of tile fabrication and maintenance information for each tile on the orbiter being measured.

The system could make the inspection process more efficient, according to Suzy Cunningham, TPS project manager at Kennedy Space Center. That, in turn, would reduce vehicle turn-around time. The technology also may have applications in other fields, including integrated circuit inspection and in manufacturing processes that require high accuracy.

For more information, contact Ann Hutchison of NASA Ames at 650-604-3039, or visit http://amesnews.arc.nasa.gov/releases/2001/01_16AR.html.

taking upward mobility to the extreme



PocketCAD® PRO 4.0—The only fully-functional mobile CAD software.

Total mobility means the freedom to create, change and communicate—anytime, anywhere. PocketCAD PRO, powered with Autodesk® technology, is the only fully functional CAD software for Windows®-powered Pocket PC's and mobile devices. PocketCAD is compatible with most desktop CAD packages and reads AutoCAD® DWG™ and DXF files from Release 12 through 2000i.

Create, edit and view design drawings at the project site, in the field, or on the manufacturing floor without a laptop or rolls of blueprints to weigh you down. And you'll gain the freedom to communicate with your team without missing a beat.

PocketCAD®
EXTREME MOBILITY.

New in PocketCAD 4.0:

- Programmability so you can build and use custom add-ins—SDK now available
- EditTrack™ automatically tracks and records file updates to simplify updates and protect master files
- Additional Unit support, a handy Hint window, and a 256 color picker
- Improved support for 2D and 3D polylines

Get extreme mobility now, to create, change and communicate for just \$199.*
Go ahead and download a free demo today at www.PocketCAD.com or contact us at 1-800-340-6388 ext 294.

© 2001 Arc Second, Inc. All rights reserved. PocketCAD is a registered trademark. The Mobile CAD Standard is a trademark of Arc Second. All other trademarks are the property of their respective owners. *Price subject to change. Hardware not included.POWERED WITH
AUTODESK
TECHNOLOGY™

For More Information Circle No. 572

Alternative Engineering:

How Virtual Reality and Simulation are Changing Design and Analysis



Interactive technology such as Fakespace's CAVE system allows designers to create models in numerous simulated environments. These engineers are working on an early model of the International Space Station.

When most people hear the phrase virtual reality (VR), they get ideas ranging from people wearing clunky headgear and strange garb, to a totally immersive environment with incredible levels of detail and interaction. In fact, virtual reality and simulation technology are both key components in a number of different areas, chief among them being manufacturing and design.

To understand what's being done with VR and simulation technology, one must understand that the differences between them are largely just a matter of interface. Both simulation and VR are tools that can be used for analyzing and testing materials, training people in numerous ways, and the design and implementation of new ideas and concepts.

The main distinction between the two is how the users operate the technology. VR often requires much more physical interaction on the user's part, while simulation typically is more passive.

Virtual reality is thought of as a very tactile process, incorporating gloves, joysticks, head-mounted displays, 3D

stereo glasses, and rear-projection video screens and walls. Simulation involves visualization software with high-end graphics — often using 3D CAD models — operating on high-speed workstations. The two are used together by designers and engineers to create almost any type of artificial world imaginable. In these digital environments, most types of real-world situations, variables, and reactions can be duplicated.

For instance, an aerospace engineer could replicate a plane in flight and subject it to a myriad of stresses, including wind shears, thunderstorms, and equipment failure. By using this simulation, the engineer can see the results of tests and variables without using physical materials and possibly risking damage to person and property. In a more VR-oriented environment, the same engineer could design a program that allows a pilot to don a pair of 3D stereo glasses and use a joystick to "fly" that simulated plane. Then, when the plane is subjected to stresses, the pilot can react to them. This would provide data for both the pilot and the engineer to improve the design of the plane and its components.

The ultimate advantage of these technologies is truly collaborative design, engineering, and analysis — enabling groups of engineers to view and manipulate, in real time, a virtual object as easily as they could a physical object.

Pioneers in Reality

Fakespace Labs, a Mountain View, CA-based virtual reality company, began as a NASA spinoff originally contracted in the early 1990s by NASA's Ames Research Center (Moffett Field, CA) to develop a teleoperated motion platform for transmitting sounds and images from remote locations. The system, called Molly™, was combined with a BOOM™ stereo viewer and software to match a user's head motions in real time. The company, now with a second division — Fakespace Systems in Ontario, Canada — provides complete VR systems that allow users to create, display, express, and explore large, complex data sets as a shared experience.

Fakespace systems transition engineers and designers from the single-user, 2D workstation to collaborative, interactive 3D environments. Systems

NEW
TEST AND
MEASUREMENT
TOOLS

Get to analysis faster. Take live measurements in MATLAB.

New test and measurement tools for MATLAB combine data acquisition, instrument



New test and measurement tools allow you to communicate with data acquisition devices and instruments directly from MATLAB.

control, and data analysis in a single, interactive environment. Now you can acquire live data from popular data acquisition devices and control your test

equipment directly from MATLAB. Use proven tools for signal processing, statistical analysis, graphics, and reporting to analyze your data as it streams into MATLAB.

Get your free 30-day trial today.

Call 508-647-7040 to request your trial. Or get a free technical information kit at www.mathworks.com/nttm.

**MATLAB®
& SIMULINK®**

Data Acquisition
Instrument Control
Signal Processing
Statistics
Training
Consulting

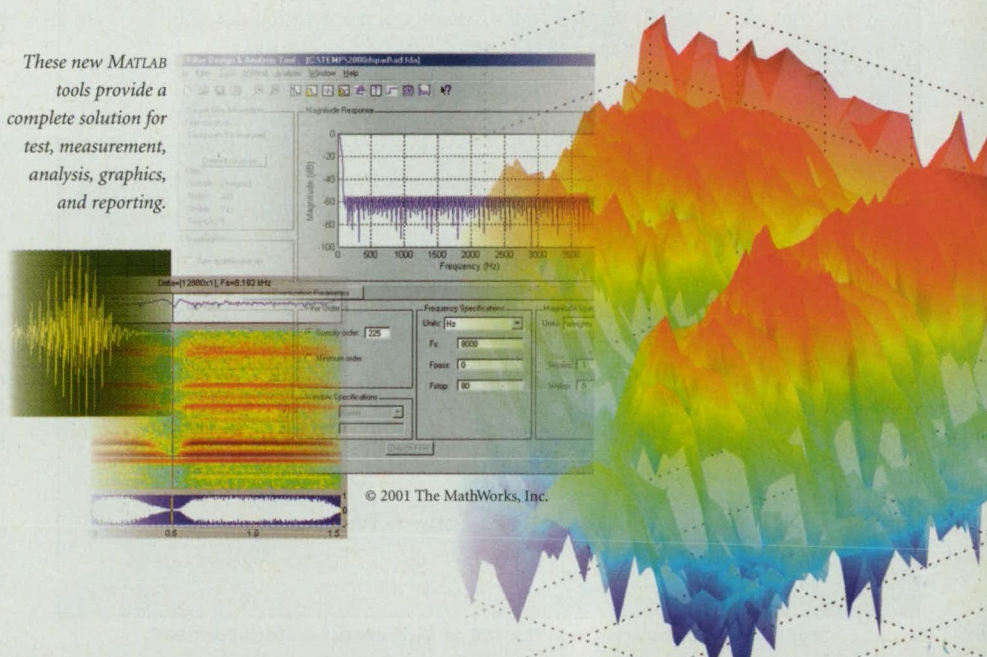
MATLAB
training
offered in
15 locations.

These new MATLAB tools provide a complete solution for test, measurement, analysis, graphics, and reporting.

The MathWorks

Visit www.mathworks.com/nttm
or call 508-647-7040

For More Information Circle No. 512



© 2001 The MathWorks, Inc.

such as the RAVE™ (Reconfigurable Advanced Visualization Environment) and CAVE® incorporate large-screen stereoscopic displays, flat walls, and immersive, walk-in theater environments.

"We are five years away from a consumer version of this type of work, although there are ways for consumers to get close to this level of detail now," said Jim Angelillo, vice president of strategic relations for Fakespace Systems. "Having a \$200 graphics card, a pair of cheap passive glasses, and the right software will let you get on the right track." Fakespace got on the right track with Dassault Systems about a year and a half ago when

Dassault began integrating Fakespace's software capabilities into its CATIA CAD software. CATIA is the first application of any kind to have native immersive visualization capabilities built in.

According to Angelillo, while there are a number of different companies in the VR and simulation fields, they all provide very similar products and product types, which is why there is generally a focus on the same markets.

"One is manufacturing, and that covers the automotive industry, aerospace, and heavy equipment manufacturing," explained Angelillo. "Then there is the military/federal and education market.

Government is by far the biggest user and that's true for any of the companies that sell VR."

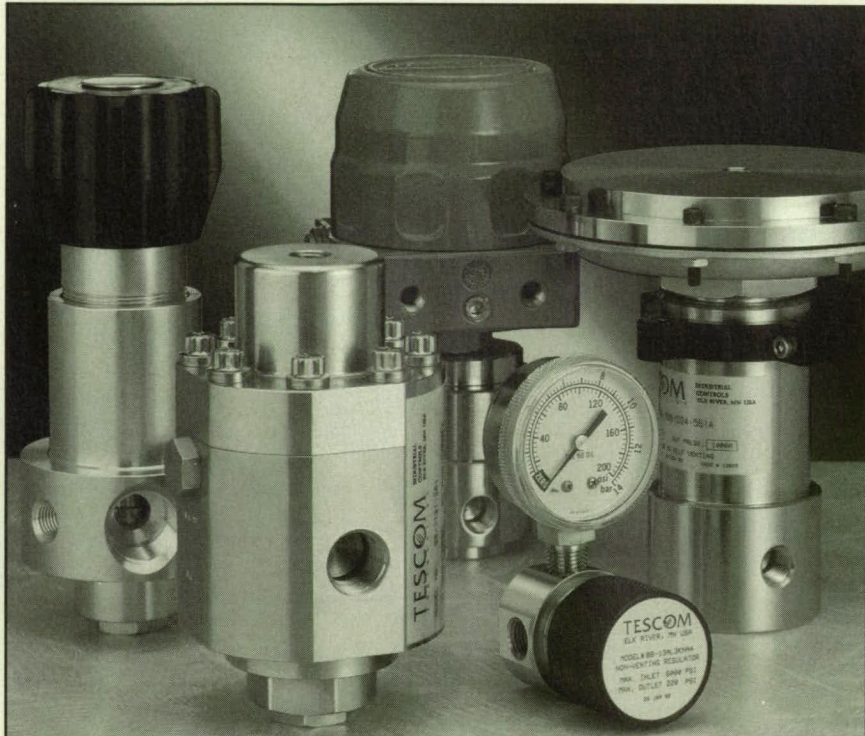
NASA Ames has been a pioneer in the virtual reality area for decades, incorporating many cutting-edge technologies and developing new applications for those innovations, including medical imaging, telemedicine, and training. From space flight simulation to designing the shuttle's successor and its capabilities, VR plays a huge part in the work that NASA does. According to Francis Govers, Government Reality Center solutions manager for SGI (Mountain View, CA), his company has provided computers for a number of NASA centers, including a visualization system at Ames, and high-speed workstations that power a number of VR systems.

The most ambitious SGI/NASA virtual reality project is FutureFlight Central, located at Ames. The \$10 million, two-story facility is designed to test — under realistic airport conditions — ways to solve potential air and ground traffic problems in a risk-free simulation environment. Twelve rear-projection video screens provide a 360-degree, full-scale, real-time simulation of an airport, allowing pilots, controllers, and other airport personnel to test out new technologies and operating techniques. The imaging system is powered by SGI workstations.

NASA's newest VR system, which was delivered earlier this year, is called the GRUVE (Glenn Reconfigurable User Interface and Virtual Reality Exploration) Lab at NASA's Glenn Research Center in Cleveland, OH. The lab features a RAVE that consists of three 8 x 8' rear-projection screens housed in moveable boxes, and powered by an SGI Onyx2 InfiniteReality2 system. The facility will display large amounts of data for engineers to look at small details, or to step back and see the big picture, according to Jay Horowitz, manager of the GRUVE Lab. The lab can be networked to other NASA centers to allow voice, data, and video communication among engineers at remote sites while working on a common project.

More Than Video Games

When companies started experimenting with the concept of creating computer programs to simulate stresses and other conditions in the early 80s, most of the focus was directed towards an industrial base of users. Now, as personal computers have become more and more powerful, simulation technology has become more accessible. And although video game development is one of the most prolific applications of virtual reality, other non-consumer uses of these



Pressure controls made *your* way!

For over 35 years, Tescom has provided a diverse range of quality pressure control solutions that meet or exceed customer expectations. Whether it's one of our 60+ standard models, a simple modification or a one-of-a-kind custom control, we'll build a regulator, valve or system that meets your unique requirements.

Control styles: pressure reducing and back pressure, hydraulic or pneumatic, electronic, miniature, cartridge, tracking, vaporizing, vacuum or changeover.

Choices: loading and sensing styles, venting options, materials of construction, seals, porting configurations and more. Pressure ranges: vacuum to 20,000 PSIG. Flow: $C_v = 0.00005$ to 8.0.

Our **application specialists** will find or create a control solution for you. Give them a call.

TESCOM
CORPORATION

INDUSTRIAL CONTROLS DIVISION

ISO 9001 Quality System Certified
MITI/KHK Product Certification

12616 Industrial Blvd., Elk River, MN 55330 800 447-9643 www.tescom.com



Our name pops up whenever there's talk about convenient ordering.

Purchasing online is quick and convenient. You get great features 24/7 . . . purchase history
. . . custom PO option . . . lease payment calculator . . . plus a quick-purchase feature.

Browse our expanded assortment of brand-name products like Fluke®, Wavetek®,
Aavid®, Belden®, Cooper®, and Icom® in categories like Test & Measurement
. . . Electronic Components . . . Business Radios . . . and Wire, Cable & Tools.

If you prefer using your phone to the computer, call our
Commercial Sales Center 800-442-7221.



 **RadioShack.com™**
COMMERCIAL AND INDUSTRIAL SALES DIVISION

Do business. Fast.

Order your free commercial catalog online at www.radioshack.com/b2b
or by calling 800-442-7221 or swipe the :Cue to visit our commercial sales site.



**Fast.
Reliable.
Safe.
Everything
automated
riveting
should be.**



**Introducing POPmatic
Point & Set™, the first
reliable auto-feed rivet
system.**

POPmatic Point & Set, our new auto-feed rivet system, delivers what no riveting tool has before. Consistent riveting at a rate faster than any current hand tool. Designed with a safe, self loading hopper that holds up to 2500 rivets, Point & Set accelerates the riveting process to previously impossible speeds, meeting the requirements of any production line. It's reliability in an otherwise unreliable world. For more information, call us at 203-925-4424 or visit us on the web at www.emhart.com

**Emhart®
POPMATIC**

A BLACK & DECKER COMPANY

CERTIFIED
ISO 9001 • QS 9000



NASA's FutureFlight Central at Ames Research Center offers a two-story training facility. In this fully interactive simulated environment, controllers, pilots, and airport personnel can try out new techniques and technologies.

technologies are becoming much more widespread.

One of the sources from which visualization and VR technology originated was the science of creating maps through photogrammetry, according to Ian Matthews, director of marketing for StereoGraphics Corp., San Rafael, CA, which provides both 3D stereo eyewear and monitors for use in visualization systems. StereoGraphics' CrystalEyes3 is a wireless eyewear system that delivers stereoscopic 3D images in conjunction with compatible software and standard workstation displays.

"Major companies in the map-making business, such as ZI Imaging and LH Systems, use our technology to allow the people creating the maps to pick the elevations in order to digitize three-dimensional data," Matthews said.



Products like StereoGraphics' CrystalEyes3 allow designers to work on simulation projects on a smaller scale.

StereoGraphics is involved in more than just topography and medical research. Like many other VR and simulation companies, one of their primary focuses is the industrial design sector. The design and production of heavy equipment and automobiles is one of the largest markets for VR. That's not just because the technology offers a faster, simpler, and easier way to design these materials, but they also provide a means

for testing them by constructing one physical model.

Across the various markets, the lack of a need for physical modeling and testing is one of the biggest advantages of simulation technology. Car companies can design and crash test a car thousands of times without damaging any physical materials. Bob Williams, development manager at ALGOR, Inc., a Pittsburgh, PA-based analysis software provider, points out that companies often begin virtual testing as simply a matter of cost savings. ALGOR specializes in both Finite Element Analysis (FEA) and Mechanical Event Simulation (MES) software. MES takes FEA models and generates their motion based on physics-based inputs and calculates stresses, displacement, and general behavior that a given part would demonstrate in the real world.

"Because of the expense and the time involved with physical testing, you want to try and iron out as many things as possible up front before you do any physical prototyping," said Williams.

Another software company, ERDAS of Atlanta, GA, provides geographic imaging solutions, such as IMAGINE Professional, which is designed to help organizations visualize, manipulate, analyze, measure, and integrate any type of geographic imagery and geospatial information into 2D and 3D environments.

Part of what makes VR and simulation technology so appealing to designers and manufacturers alike is the ease with which it can incorporate existing designs. Most design work for manufacturing is done with some form of 2D or 3D CAD software. Since virtually all simulation systems operate with the OpenGL graphics standard, importing a CAD model and applying physics to it — such as putting a car frame model into a wet road simulation — is practical and cost



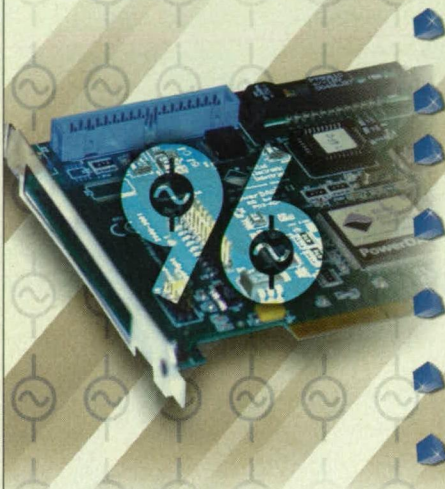
IF YOU CAN THINK IT, WE CAN DO IT.

Emhart is a world leader in the design and supply of innovative fastening and assembly technology. From concept through installation, whether you're manufacturing around the corner or around the globe, Emhart provides cost-effective solutions for assembly applications. Visit us at www.emhart.com

Emhart®

A BLACK & DECKER COMPANY

The PD2-AO-96/16 provides seemingly **UNLIMITED ANALOG OUTPUTS** on one card



- 96 D/A converters
(32/16/8 channel versions available for PCI and cPCI)
- 16-bit/100 kHz outputs*
- Simultaneous outputs on all channels
- 64k-sample waveform memory (optional)
- Drivers for Windows/QNX/Linux/RTLinux
- Pinouts identical to boards from Keithley, Measurement Computing/CBI
- Replaces six 16-channel boards from other suppliers

* 2 MS/s total throughput



10 Dexter Avenue, Watertown, MA 02472
Tel: (617) 924-1155, (800) 829-4632; Fax: (617) 924-1441
Internet: www.PowerDAQ.com

For More Information Circle No. 404

effective. While engineers may have to learn how to operate the simulation technology itself, they still have other familiar design tools at their disposal.

Tools of the Trade

According to SGI's Govers, having the right equipment is the first and most important step in running a VR system. "In order to do large-scale 3D graphics," he said, "first of all, you have to have a fast computer. Second of all, you have to have the ability to bring data in and out of that computer very quickly and at very high bandwidth."

Other high-end computer suppliers, in addition to SGI, are working to make super-fast workstations more accessible. Hewlett-Packard offers the HP Visualize Center, a fully immersive visualization system powered by three synchronized HP j6000 workstations with Visualize-fx10pro graphics. The machines work in tandem with large-scale 3D stereographic display systems and OpenGL software to bring products to life in a seamless, wide-field display.

The HP Visualize workgroup solution is a smaller, desktop version built around a single dual-processor HP j5600 workstation. The workgroup drives seamless displays that can be deployed right into the engineering workspace or on the engineer's desk.

Connecting the user to the equipment is just as important as having the right equipment. One of the constant themes in VR and simulation technology is ease of use. As markets and uses for the technology continue to broaden, the people who are using it aren't necessarily trained to understand simulation coding and physics. Williams stressed the fact that the human part of the equation is becoming more and more vital as the field advances.

"It is one thing to provide a tool that can do all these sorts of simulations," said Williams. "It is another thing to provide a tool that makes it easy to do this. We've also spent a lot of time focused on making the set-up and just building on these models, utilizing these models, and also looking at results and how they behave."

By focusing on how everything works, Williams explained that it makes it easier to understand how to make the systems more intuitive. For a company like ALGOR, which focuses on finite element analysis and mechanical event simulation, the goal is making sure users can understand what stresses they are applying to their models.

For a company like SGI, which offers a broader range of simulations, the need for ease of use is much more about how



SEALING SOLUTIONS

FOR ALL PROCESSING APPLICATIONS

AMERICAN VARISEAL • BUSAK + SHAMBAN • DOWTY ENGINEERED SEALS
FORSHEDA • PALMER-CHENARD • SILCOFAB • WILLS

• Turcon®, Turcite®, HiMod®, Zurcon®, Luytex®, and Orkot® Marine
and other high performance materials available
• Designs and materials for wide range of applications.

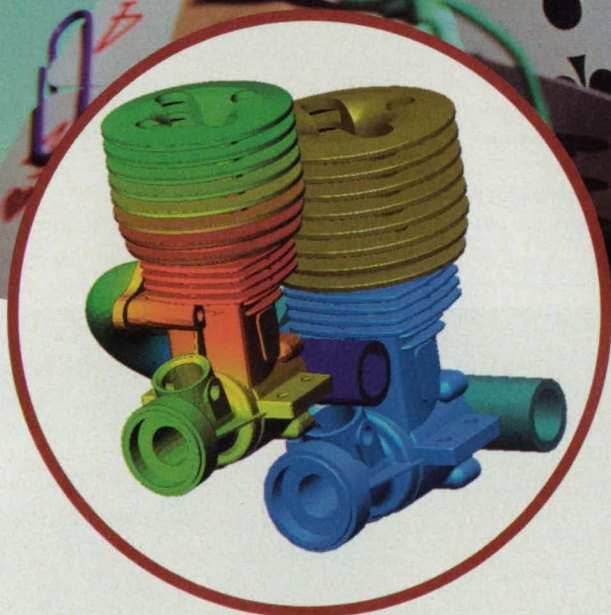
Call: 1-800-767-3257

Fax: 1-303-469-4874

Specialty Polymer Products

Specialty Polymer Products
2531 Bremer Drive, P.O. Box 176, Fort Wayne, IN 46801
Tel: (219) 748-5703 • Fax: (219) 749-4208
email: sales@bsmail.com • web: www.polymersealing.com

a smiths group company



Are you Sure You have A Good Design?

Will it overheat? Will the stresses be too high? Will it break? If you are designing your models without using analysis, you could be risking a potential part failure - without even realizing it.

Don't take unnecessary chances with your design. Use COSMOS/TM throughout the design cycle to help identify potential problems before it's too late.

COSMOS/WORKS
COSMOS/DESIGNSTAR

With COSMOS/, engineers are building better, more cost efficient products while taking weeks, even months off of the design cycle.

COSMOS/ tackles even the most complex design tasks, while being intuitive enough for any engineer to quickly learn and use, regardless of previous experience.

For information on how COSMOS/ can help you work smarter instead of harder and a **FREE** 15-day trial, call us today at **1-800-469-7287** or visit us online at <http://nasa.cosmosm.com>.

© Copyright 2001, Structural Research & Analysis Corp. Trademarks are the property of their respective owners.

For More Information Circle No. 545



This digital environment, created by ERDAS' IMAGINE VirtualGIS software, is an example of the level of detail and scope that can be obtained using VR and simulation technology.

the people respond to what they are seeing on screen.

"The term I like to use is increasing the human bandwidth," says Govers. "We want to be able to get information to people quicker and make it easier to understand and to make it easier to get from where it's data to where it's information. Make it more of a natural interface."

The human aspect of virtual reality is what will drive the market from where it

environment takes more than just cool imagery. It's all in the details. Enhanced 3D graphics software, high-resolution projection screens, lightweight stereo eyewear, and super-fast computers all will continue to evolve and result in more realistic virtual environments for collaborative engineering.

Visit www.nasatech.com/features for more comments from industry leaders on virtual reality and simulation.

is now — more affordable and easier to use than it was five years ago, but still not perfected. "The thing that virtual reality requires is more and more of the senses being able to interact with the computer environment," said StereoGraphics' Matthews. "Today, the primary senses that are being exercised are vision and feel."

Feeling that you're actually present in a computer-generated

Get Connected to the Companies Featured in this Article:

ALGOR
www.algor.com

ERDAS
www.erdas.com

Fakespace Labs/Fakespace Systems
www.Fakespace.com

Hewlett-Packard
www.hp.com

NASA's Ames Research Center
www.arc.nasa.gov

SGI
www.sgi.com

StereoGraphics Corp.
www.stereographics.com

REAL TIME PATTERN RECOGNITION

IDEAL FOR IMAGE, VOICE AND SIGNAL PROCESSING

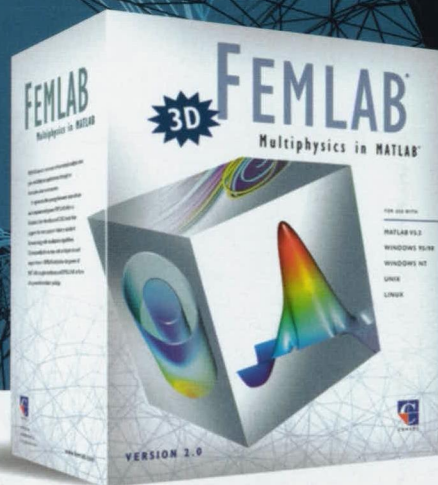
- Massively parallel processing
- Recognition time independent of all known patterns
- Learning by example
- Programming-free, Modeling-free
- 200,00+ recognitions/second
- Equivalent to 13.2 billion instructions/second (13.2 GIPS)
- Reconfigurable technology using FPGA on a PCI board

ZISCBlaster

ZISCBlaster provides, in a single, cost-efficient short PCI board, more processing power than any available DSP configuration for pattern recognition.

Silicon Recognition, Inc.
1150 Industrial Avenue, Suite C
Petaluma, CA 94952
(707) 765-6296
www.silirec.com
e-mail: sales@silirec.com

Engineering in a box.



FEMLAB® — MULTIPHYSICS MODELING
Based on the finite element method, FEMLAB is a powerful tool for solving coupled systems of partial differential equations. In addition, FEMLAB includes ready-to-use applications for computational electromagnetics, fluid dynamics, transport phenomena, structural mechanics and much more.

Order a **FREE Model Library!**



Visit www.femlab.com/ient

or call **781-273-3322**

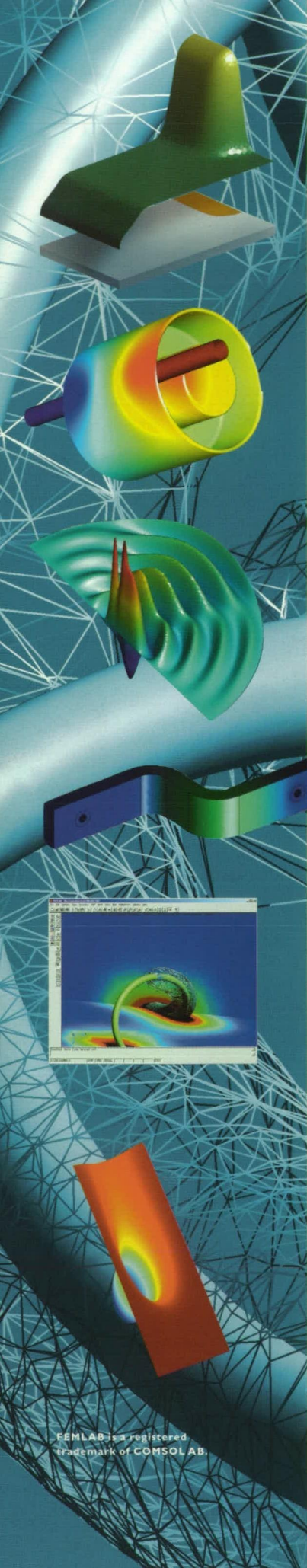
EUROPE: **+46 8 412 95 00**

FEMLAB® Application Specific Solutions:

- Multiphysics
- Structural Mechanics
- Chemical Engineering
- Computational Electromagnetics



www.comsol.com



- ▶ The semiconductor formulation can be derived from Maxwell's equations and Boltzmann transport theory. The problem can be formulated for three independent variables and strong nonlinear dependencies are present. Similar problems arise in the modeling of photonic devices. FEMLAB's advanced design, which allows for arbitrary couplings, provides engineers the flexibility they need to model such phenomena.

The design of equipment that is expected to perform at high voltage requires careful evaluation. This model studies the electrical properties of the insulation between the electrodes in an HV connector.

The propagation of alternating fields is studied by using the $j\omega$ method, which is readily available to you through FEMLAB's graphical user interface. FEMLAB includes a number of other ready-to-use applications for computational electromagnetics.

FEMLAB is able to arbitrarily couple different physical phenomena. In this case, the heat generation in a current collector is studied as a function of current density. The current and heat balances are fully coupled through the dependence of the conductivities of temperature and through the heat exerted by the current passing through the collector.

Electrostatic precipitators are often employed to remove particles from effluent gases. The electrodes in these units are often helical shaped. The figure shows the electrical field in the vicinity of the helix during operation of the filter.

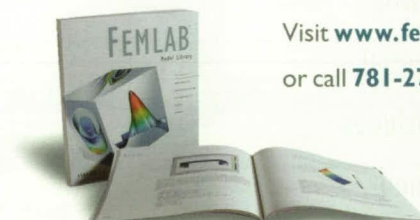
FEMLAB KEY FEATURES

- Flexible and powerful graphical user interface
- Built-in user-friendly CAD tool for solid modeling in 1D, 2D and 3D
- Automatic mesh generation, adaptive mesh and multigrid
- Powerful solvers for linear, nonlinear and time dependent systems of partial differential equations (PDEs)
- Extensive postprocessing capabilities
- Model Libraries with over fifty fully documented models from various engineering fields
- Ready-to-use application modes for different engineering fields
- Equation based modeling for arbitrary system of PDEs

FEMLAB puts you in the frontline

FEMLAB employs sophisticated numerical techniques developed by our staff of leading scientists in collaboration with industry experts from around the world. These scientists had a goal of making modeling available to every engineer and scientist. FEMLAB is the result of our commitment to putting engineering mathematics in a box.

Order a FREE Model Library!



Visit www.femlab.com/ient

or call **781-273-3322** EUROPE: **+46 8 412 95 00**

FEMLAB® Application Specific Solutions:

- Multiphysics
- Structural Mechanics
- Chemical Engineering
- Computational Electromagnetics



www.comsol.com

FEMLAB is a registered trademark of COMSOL AB.

PHOTONICS Tech Briefs

PHOTONICS SOLUTIONS FOR THE DESIGN ENGINEER

The Many Facets of Raman Spectroscopy.....	11a
Pyramid-Shape Light Coupler for Multi-Quantum-Well Photodetectors	6a
Noise-Reducing Slots in Quantum-Well Infrared Photodetectors.....	6a
Adaptive Focal-Plane Detector Arrays for Optical Communications	8a
Two-Axis Scanning Mirror in a Small Package	10a
Hot Dielectrics as Light Sources for TPV Devices and Lasers	11a
Polarization Recycling for Lighting LCDs More Efficiently	12a
Photonics File	4a
New Products	14a

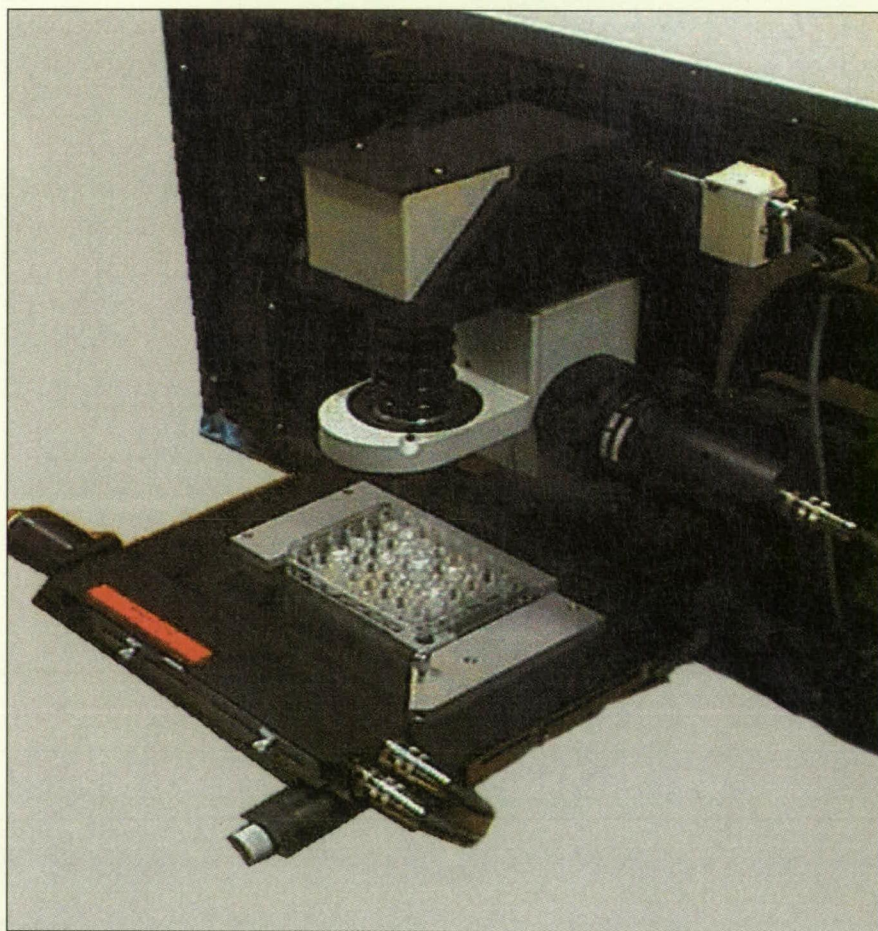
The Many Facets of Raman Spectroscopy

A mature analytical technique finds new means and applications.

As a tool for determining the chemical content of a sample, or some other property, spectroscopy has been around a long time. But still the industry continues to improve the techniques and the equipment, making life easier – and analysis times shorter – for the researcher in the laboratory. And as more powerful and more compact lasers are developed for the needed excitation wavelengths, mature techniques such as Raman spectroscopy gain new adherents.

According to Thermo Nicolet Instruments of Madison, WI, the spur that made Raman spectroscopy a routine analytical method was the development of Fourier transform detection techniques. Fourier transform IR (FT-IR) instruments measure the interaction of infrared radiation with samples. Both the absorption frequencies and the absorption intensity of the radiation are recorded. The frequency data is used to determine the sample's identity, and the intensity information the concentration of the material or materials of interest.

In FT-IR Raman spectroscopy the 2D spectral plot shows Raman shift emission along the x-axis rather than intensity, as in competing methods. When near-IR light strikes it, the sample scatters Raman radiation, at slightly longer (Stokes lines) or slightly shorter (anti-Stokes lines) wavelengths than that of the laser that causes the excitation. After the scattered light is detected, the computer, using the Fourier transform process, converts the data into a spectrum. Among the experiments and analytical methods now using FT-Raman are monitoring real-time polymerization reactions at controlled temperatures and using fiber optic probes to identify nuclear waste materials remotely.



Jobin Yvon's Raman Multiwell Analyzer

Thermo Nicolet points to research and development of new products, quality control of manufactured goods and incoming materials, forensic analysis, environmental testing, and other applications where FT-IR analysis proves valuable. The company says FT-Raman has particular relevance to measuring polymers, pharmaceuticals, aqueous materials, biological substances, hazardous and

explosive materials, drugs, inorganic materials, and reaction monitoring.

Top of the Line

Thermo Nicolet offers a broad range of spectrometers and other spectroscopic instruments. At what it calls the "pinnacle" of its "Pyramid of Power" is the Nexus 870. The device includes all of the standard features of its Nexus line of

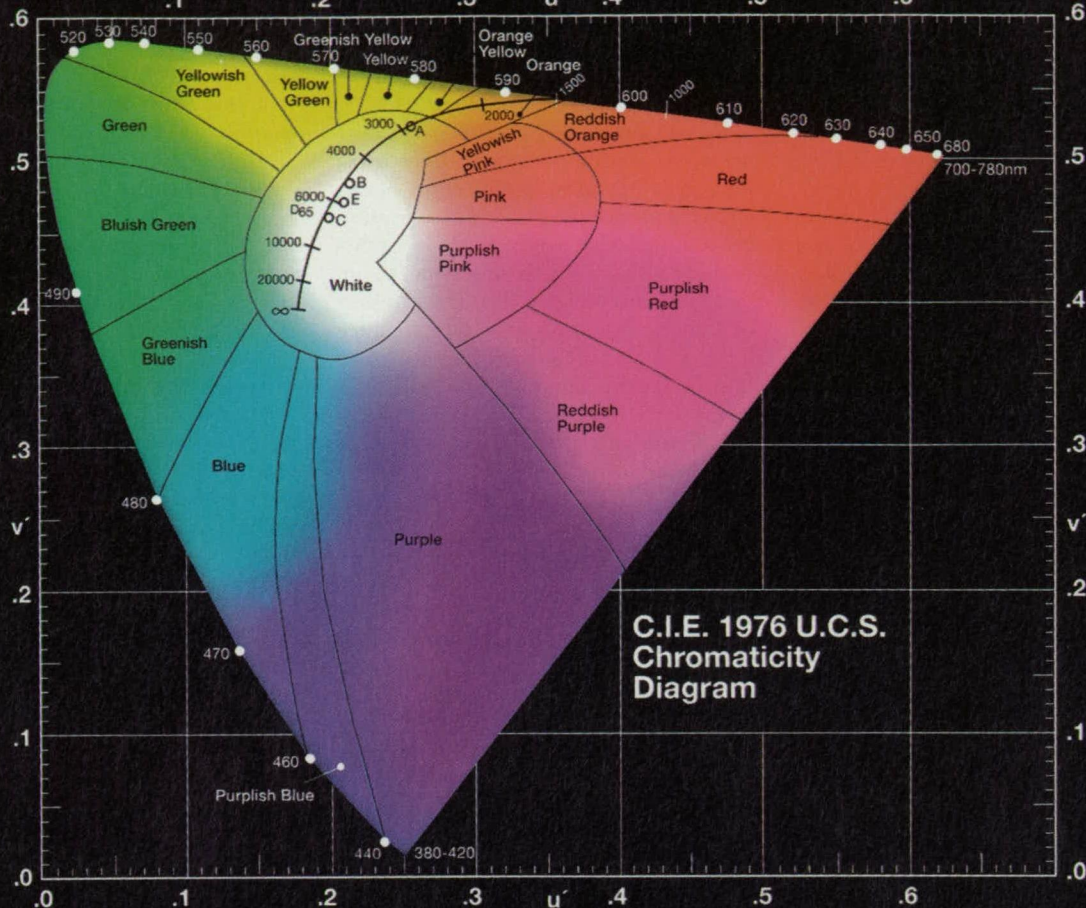


Diagram courtesy of Photo Research, Inc.,
"The Light Measurement People."

What color of laser light do you want?

That's right, pick your laser light color. With our nitrogen pumped dye laser system, you can tune from 360 nm to 950 nm to get the color of laser light you want.

No, no, no! No flowing nitrogen, no running water, no pumping dyes. With our system, you just plug in and turn on. Then select the wavelength for your research and start taking data. It is that simple.

For UV light, add our doubling module. If you could see UV, you could watch it tune from 220 to 320 nm.

Talk to us about the color of laser light you want and what you want to do with it. We would love to help!

Thermo Laser Science 8E Forge Parkway Franklin, MA 02038
www.laserscience.com 508-553-2353 fax: 508-553-2355

Thermo Laser Science

provider of low cost laser light from UV through IR

For More Information Circle No. 484 or Visit www.nasatech.com/484

research FT-IR spectrometers, combined with other advanced research capabilities. These include phase modulation step-scan spectroscopy, for photoacoustic depth profiling; dynamic polymer stretching step-scan; time-resolved step-scan spectroscopy; and amplitude modulation step-scan spectroscopy. Other capabilities are dual-channel collection for PM-IRRAS, advanced scanning velocities for rapid scan and slow scan, and extended spectral range (from 25,000 to 20 cm^{-1}), and hyphenated techniques such as advanced infrared microscopy and FT-Raman spectroscopy.

Among FT-Raman systems, Thermo Nicolet offers the FT-Raman 960, which the company says was designed for corporate or academic researchers who want the optimum in FT-Raman performance. It uses gold-coated reflective optics throughout its high-throughput optical design. The 960 offers the ability to search unknown spectra against several commercial libraries. It allows data collection with no sample preparation, and collection from aqueous solutions without strong interference from the water content. It also allows nondestructive sampling through thin plastic bags, blister packs, or glass bottles without the need to remove or have contact with the samples inside.

From another leading supplier of spectroscopic systems, Kaiser Optical Systems, of Ann Arbor, MI, a Rockwell Collins company, comes a wide range of instruments providing Raman or other kinds of spectroscopic techniques. Prominent among these is the HoloLab Series 5000 modular Raman spectrometer. Kaiser says that its modular architecture provides experimental versatility and stability, yet allows for future expansion or upgrading. At its heart is Kaiser's axial transmissive imaging spectrograph design, which combines fast $f/1.8$ optics with HoloPlex™ transmission grating technology. This grating, and the instrument's multichannel CCD array detector, yields spectral coverage from 100 to 4400 cm^{-1} with 532-nm excitation without aperture sharing or scanning. Kaiser Optical says this means reduced data acquisition times per sample.

The Series 5000 spectrometer can be outfitted with the Mark II holographic filtered probehead (HFPH), which Kaiser says will supply high signal-to-background measurements. This probehead uses a single fiber for excitation and another for collection. Standard telecommunications fiber diameters

(less than 100 microns) result in increased mechanical stability.

Kaiser says that, for process equipment, single fibers reduce the cost of long runs of multiple collection fibers, and also permit multichannel operation on a single spectrograph. Noncontact optics with working distances of 0.1 in. to 17 in. can measure through windows or bottles, or simply at a safe distance from a sample. Immersion and insertion optics use single, double, or triple window designs to allow safe, direct installation into reaction vessels or process streams.

Instant Collection

The HoloLab Series 5000 Raman integrated system is also based on Kaiser's axial transmissive imaging spectrograph design, featuring $f/1.8$ optics and HoloPlex transmission grating technology. The company says that the entire Raman spectrum is collected instantaneously at high resolution by optically folding the scattered Raman photons onto a large-format multichannel CCD detector. Options include a Raman microscope, a remote filtered probehead, and a Class 1 sampling compartment, as well as three excitation wavelengths (532, 633, or 785 nm). Alternative gratings, cameras, and laser sources are available. Kaiser says Windows®-based HoloGRAMS™ data acquisition and GRAMS/32/®C spectral analysis software makes Raman data easily acquired and quickly analyzed.

Also incorporating the HoloPlex grating technology is Kaiser's line of RamanRxn2 analyzers, which, like the HoloLab Series 5000, collect the entire Raman spectrum instantaneously at high resolution. This enables the collection of wavelengths of chemically changing samples such as polymerizations, curing, and bubbling solutions or species with widely separated analytical bands of interest. Kaiser says more accurate quantitative analysis results, and that the modular instrument design and fiber optic coupling provide robust performance and analyzer stability.

Kaiser's entries in the telecommunications arena are the UltraSpec-C 160 and UltraSpec-L160 for DWDM network monitoring applications. The C-160 has the range and resolution necessary for characterization of the telecommunications C-band spectrum at 50-GHz channel spacing, while the L-160 extends that to the L-band spectrum. Expanding on holographic optics deployed in Raman spectrographs and military avionics, the

patent-pending UltraSpec grating/prism structure uses a Volume Phase Holographic (VPH™) transmission grating recorded in dichromated gelatin and sealed between two precision prisms. Kaiser says the expanded beam footprint on the grating, much larger than the beam cross-section, results in a combination of high dispersion and high resolution in a very compact package.

High-Throughput Screening

According to sources at Jobin Yvon, the spectroscopy arm of the Horiba group, based in Edison, NJ, the latest approach in analytical technology is high-throughput screening. This technique has become important in the pharmaceutical industry and in life-science laboratories, where it is used in screening of drug design and analysis of batch production. JY Horiba says the new Raman Multiwell Analyzer was specifically constructed for use in the manufacturing environment. High-throughput applications mean the sample reaction process is undertaken in multiwell plates, and this instrument, based on JY Horiba's analytical LabRAM system, has been adapted for use as a fully automated multiwell analyzer. The company says its new optical designs mean a single multiwell plate – the standard is 12 × 8 – can be analyzed in a matter of seconds. Additional features include a dedicated long-travel autofocus system to compensate for different well filling heights; two selectable gratings inside the spectrometer, allowing either high-resolution mode or quick analysis with full spectral coverage; and full integration of different lasers.

Get connected with the companies mentioned in this article:

Thermo Nicolet Instruments Corp.

(608) 276-6100

www.nicolet.com

Kaiser Optical Sciences Inc.

(734) 665-8083

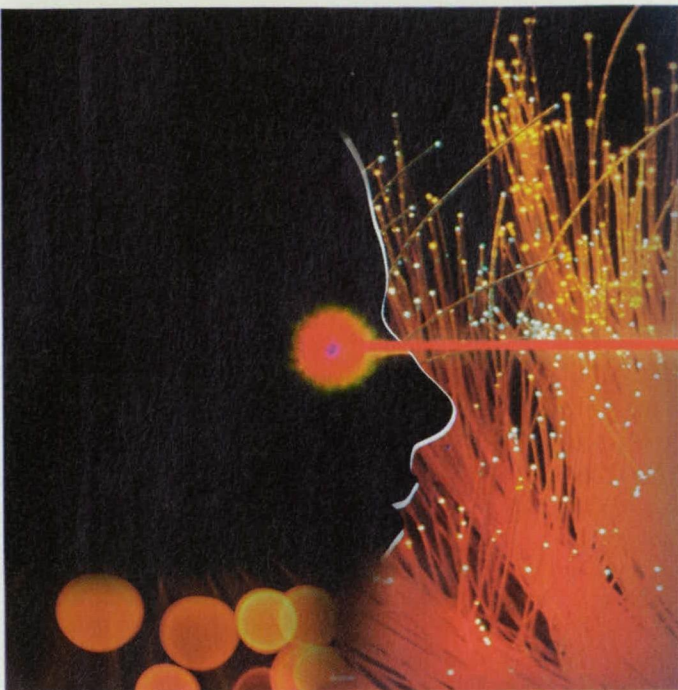
www.kosi.com

Jobin Yvon Inc./Horiba

(732) 494-8660

www.jyhoriba.com

Align yourself with telecom's most accurate imaging tools.



Indium Gallium Arsenide. The detector material of choice for imaging laser energy in the 1.3 and 1.55 micron C, L and S wavebands used by DWDM telecom lasers. Indigo's **PHOENIX™** and **MERLIN™** camera families offer imaging solutions based on a combination of high-performance InGaAs detector material and our proprietary ultra-low noise ISC9809 analog signal processor. **PHOENIX** and **MERLIN** are excellent choices for laser beam characterization, including outputs from optical fibers, optical components, or diode lasers. Both cameras allow the user to directly illuminate the sensor with laser energy and capture 12- or 14-bit corrected digital images at high frame rates.

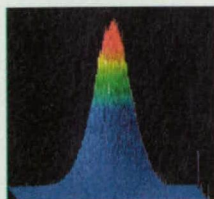


FEATURES INCLUDE:

- 320 x 256 pixel snapshot-mode InGaAs Focal Plane Array
- Sensitive in the 0.9-1.68 μm waveband
- Excellent response linearity (<1% nonlinearity)
- Excellent spatial uniformity (<0.2% nonuniformity)
- Adjustable integration times as low as 0.5 microseconds
- Very resistant to laser damage

Discover more about our laser analysis solutions at www.indigosystems.com.

Indigo Systems. Superior imaging tools for advanced telecom systems.



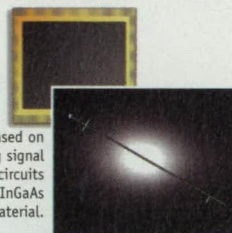
Surface plot of 1.55 μm laser intensity.

Indigo™

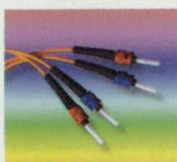
SYSTEMS

Advanced Sensors for Tomorrow's Telecommunications

Our IR cameras are based on our proprietary analog signal processing integrated circuits combined with InGaAs detector material.



Laser diode output imaged directly onto the camera's sensor.

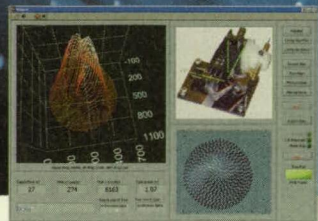


www.indigosystems.com/lsr-ptb/

5385 Hollister Ave. #103 • Santa Barbara, CA 93111 • Tel. 805-964-9797 • Fax 805-964-7708

For More Information Circle No. 485 or Visit www.nasatech.com/485

Powerful Motion/Vision Integration



Integrate motion with vision and data acquisition.

Motion Control

- Servo and stepper
- Updatable firmware
- Configuration utilities

Machine Vision

- Easy to program
- High-level machine vision functions
- Flexible hardware

Integration

- High-speed, synchronized bus
- Platform choices – PXI™/CompactPCI™
- LabVIEW™ and Measurement Studio™

ni.com/info

Visit ni.com/info and enter **nadr23**
for motion/vision solutions



(800) 811-0742

Fax: (512) 683-9300 • info@ni.com

© Copyright 2001 National Instruments Corporation. All rights reserved. Product and company names listed are trademarks or trade names of their respective companies.

PHOTONICS *file*

Recent photonics briefs published in NASA Tech Briefs

Many photonics-related briefs from NASA's field center laboratories appear in *NASA Tech Briefs* rather than in the *Photonics Tech Briefs* supplement. Listed here are some from issues of *NASA Tech Briefs* just past, edited for brevity and indexed with reference to original publication and the availability of a Technical Support Package on *Photonics Tech Briefs'* web site.

NASA Tech Briefs February 2001, page 42

Optical Measurement of Temperatures in Muscles and Tendons (NPO-20562)

Miniature fiber-optic-coupled sensors based on optically excited, self-resonant microbeams have been proposed by a Jet Propulsion Laboratory team for measuring temperatures within muscle fascicles and tendons. The proposed sensors could be used in medical and biological research on humans and other animals. Each sensor would be made of electrically nonconductive materials that are chemically and galvanically inert with respect to living tissue. Typical sensor dimensions would be about 0.5 by 0.5 by 0.1 mm. These dimensions are suitable for surgical implantation; they are also comparable to diameters of cores of multimode optical fibers, making the sensors amenable to fiber-optic coupling.

For further information, access the Technical Support Package (TSP) **free on-line** at www.ptbmagazine.com under the *Test and Measurement* category.

NASA Tech Briefs April 2001, page 34

High-Speed Image Compression via Optical Transformation (NPO-20638)

A method of compressing image data proposed by a Jet Propulsion Laboratory scientist would exploit the capability of a converging lens to generate the Fourier transform of an image by purely optical means, in much less time than is needed to compute the discrete Fourier transform of a sampled image by use of digital electronic circuits. Because the transform, of whatever kind, is the most computation-intensive part of almost any electronic image-compression scheme, the speedup afforded by this method could make the difference between success and failure in applications in which data must be compressed at high throughput rates.

For further information, access the Technical Support Package (TSP) **free online** at www.ptbmagazine.com under the *Physical Sciences* category.

NASA Tech Briefs April 2001, page 37

Algorithms for Recognition of Objects in Color Stereo Images (NPO-20754)

A researcher at Jet Propulsion Laboratory has developed algorithms to enable a robotic vision system to recognize, in real time (at a rate between 0.5 and 2 frames per second), known objects lying on the ground. Raw data from a pair of color stereoscopic images are subjected to rapid preliminary processing to detect candidate locations to be more thoroughly examined. Once the candidates have been detected, additional computations are performed to reduce false alarms, reason about the remaining available image data, and make a final decision about each candidate.

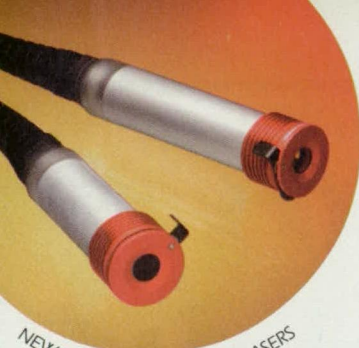
For further information, access the Technical Support Package (TS) **free online** at www.ptbmagazine.com under the *Information Sciences* category.

NASA Tech Briefs April 2001, page 38

Infrastructure Software for Mining Image Data Bases (NPO-20921)

A team at Jet Propulsion Laboratory has developed Diamond Eye, a computer program that enables a user equipped with only a personal computer, web-browser software, and a network connection to analyze large collections of scientific image data. The system is based on a distributed applet/server architecture that provides platform-independent access to image mining services. The computational engine provides parallel execution of the most demanding parts of the data-mining task: image processing, object recognition, and querying-by-content operations. Diamond Eye is currently being used to locate and catalog geological objects in large image collections, but the design provides infrastructure for a range of scientific data-mining applications.

For further information, access the Technical Support Package (TSP) **free online** at www.ptbmagazine.com under the *Software* category.



NEW ULN-SERIES DIODE LASERS



NEW CIRCULAR AND HIGH POWER VIOLET LASER SYSTEMS

Coherent. World Leader in Laser Diode Modules.

SCIENTIFIC

INDUSTRIAL

MEDICAL

COMMERCIAL

- Wavelengths from 395 nm to 830 nm
- Various output powers up to 70 mW
- Beam collimation and alignment with patented Alignlock™ technology
- Small cylindrical packaging
- Integral drive circuitry with active laser power control
- Maximum protection from environment
- Custom OEM subassemblies and "light engines"
- Ultra low noise, mode hop free devices

APPLICATIONS

- Cytometry
- Genomics
- Alignment
- Aiming
- Medical Imaging
- Printing/Reprographics
- Particle/Cell Sorting and Counting



NEW WAVELENGTH SELECTABLE VIOLET DIODE LASER SYSTEMS



OEM SUBASSEMBLIES

Coherent Auburn Division is pleased to help you adapt and design any of our diode laser module and subassembly capabilities into your demanding application. Whether you are involved with **Cytometry, Genomics, Reprographics, Medical Imaging, Particle/Cell Counting, Alignment, Aiming, or other applications**, our expert application and design team will be happy to assist you.



NEW HIGH POWER 635 nm DIODE LASERS



A Member of Coherent Photonics Group



2303 Lindbergh Street
Auburn, CA 95602
Toll Free: 1-800-343-4912
Tel: (530) 889-5365
Fax: (530) 889-5366

<http://catalog.Coherentinc.com/IL.html>

UK Free Phone: 0800 515801
Germany +49-6071-968-303
France +33-1-60 19 40 40
Japan +81 (0) 3 5635 8680

Pyramid-Shape Light Coupler for Multi-Quantum-Well Photodetectors

Light-coupling efficiency should exceed that of corrugated couplers.

NASA's Jet Propulsion Laboratory, Pasadena, California

Wavelength-independent light couplers in the form of planar arrays of pyramids have been proposed for use on multiple-quantum-well infrared photodetectors. Wavelength-independent light couplers are needed for focal-plane arrays of QWIPs designed to operate in multiple and/or broad wavelength bands. In the proposed pyramid light couplers, wavelength independence would be achieved by sizing and shaping the pyramids to exploit reflections and refractions that, to a first approximation, depend on geometry only.

Because of a quantum selection rule related to polarizations, a quantum-well infrared photodetector (QWIP) does not absorb light incident normal to the planes that make the quantum-well layers: The rule arises because the quantum wells can absorb only light polarized perpendicularly to the planes that bound the quantum-well layers, whereas normally incident light is polarized parallel to these planes.

Most commonly, a QWIP device is fabricated so that the planes that bound the quantum-well layers are parallel to the broad outermost faces of the device; therefore, by virtue of this quantum mechanical selection rule, light incident normal to these faces is not detected. A light coupler is needed to redirect inci-

dent light so that it traverses the QWIP layers in a direction that includes at least some vector component parallel to the planes that make the quantum wells. In other words, the function of a light coupler on a QWIP is to redirect normally incident light to oblique incidence.

Heretofore, the only wavelength-independent light couplers for QWIPs have been corrugated ones – parallel ridges and valleys. A corrugated light coupler can redirect normally incident light in a direction with vector component perpendicular, but not parallel, to the ridge lines. On the other hand, a pyramidal light coupler could redirect normally incident light along directions with vector along both mutually perpendicular axes in a plane parallel to the quantum-well surfaces; as a result, light should be coupled more efficiently by a pyramidal than by a corrugated coupler.

Corrugated light couplers are fabricated by wet chemical etching that is selective with respect to crystallographic planes. Consequently, a corrugated light coupler can be oriented only parallel to one crystallographic plane; it is not possible to fabricate two crossed, superimposed corrugated light couplers by wet chemical etching to obtain a pyramidal light coupler.

The proposed pyramidal light couplers would be fabricated by poly(meth-

methacrylate)- (PMMA)-pattern-transfer techniques: In preparation for fabricating an array of pyramids on a GaAs-based QWIP, PMMA would be spun over the surface of the GaAs epitaxial material. A pattern corresponding to the array of pyramids would be formed in the PMMA by electron-beam lithography and development of the electron-beam-exposed PMMA. Finally, the pattern would be transferred to the epitaxial GaAs by reactive-ion etching in a plasma generated by electron cyclotron resonance.

This work was done by Sarath Gunapala, Sumith Bandara, and John K. Liu of Caltech for NASA's Jet Propulsion Laboratory. For further information, access the Technical Support Package (TSP) free on-line at www.nasatech.com under the Electronic Components and Systems category.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to

Technology Reporting Office

JPL

Mail Stop 249-103

4800 Oak Grove Drive

Pasadena, CA 91109

(818) 354-2240

Refer to NPO-20521, volume and number of this NASA Tech Briefs issue, and the page number.

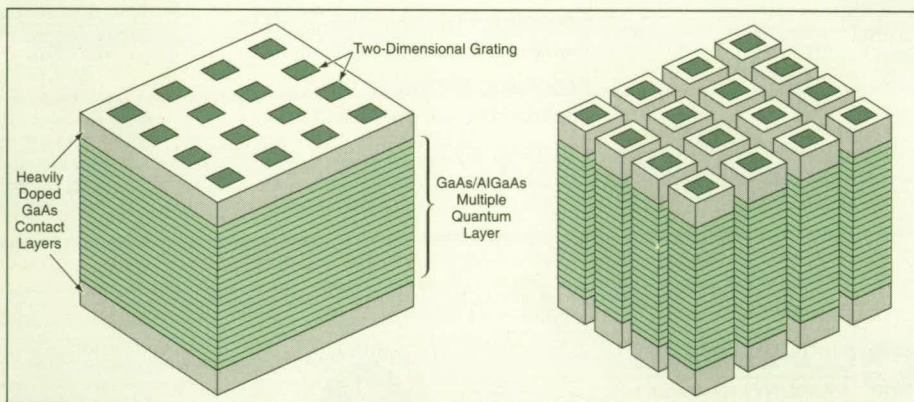
Noise-Reducing Slots in Quantum-Well Infrared Photodetectors

Dark currents would be reduced.

NASA's Jet Propulsion Laboratory, Pasadena, California

Quantum-well infrared photodetectors (QWIPs) that include two-dimensional surface grating light couplers would be modified, according to a proposal to incorporate crossed slots. It should be possible to increase signal-to-noise ratios by suitable positioning and dimensioning of the slots, as explained below.

The figure depicts part of a typical GaAs/AlGaAs QWIP with a two-dimensional surface grating light coupler. The need for, and function of, a light coupler on a QWIP is described in the preceding article. In the case of a two-dimensional surface



A QWIP With a Two-Dimensional Surface Grating Light Coupler would be modified by incorporation of slots in regions where little light is absorbed.

grating light coupler, there is an important effect incidental to the basic light-coupler function; the absorption of light inside the QWIP becomes concentrated into columns under the surface grating.

Because little or no light is absorbed in regions between the columns, material could be removed from these regions without reducing photocurrent much, if at all. This leads to the concept of slots. The positions and dimensions of the slots would be chosen to correspond to the low-absorption regions.

While the incorporation of slots would exert little or no effect on photocurrent, it would significantly affect noise. The dark current of a QWIP is proportional to its effective area. In the presence of slots, the effective area would be the cross-sectional area of the columns between the slots. In a typical case, this remaining area would be only one-fourth the original area; consequently, the dark current of the slotted QWIP would be only one-fourth the dark current of the unslotted QWIP. Inasmuch as the noise current of a QWIP is proportional to the square root of its dark current, the noise current of the slotted QWIP would be reduced to half that of the unslotted QWIP, resulting in a signal-to-noise ratio twice that of the unslotted QWIP at any wavelength and temperature.

Another anticipated benefit of slotting would be an increase in the fraction of incident light converted to polarization perpendicular to the planes bounding the quantum wells and thus an increase in light-coupling efficiency. The estimated net effect of slotting would be an enhancement of detectivity by a factor of 3 to 4.

This work was done by Sarath Gunapala, Sumith Bandara, John K. Liu, and Daniel Wilson of Caltech for NASA's Jet Propulsion Laboratory. For further information, access the Technical Support Package (TSP) free on-line at www.nasatech.com under the Electronic Components and Systems category.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to

Technology Reporting Office

JPL

*Mail Stop 249-103
4800 Oak Grove Drive
Pasadena, CA 91109
(818) 354-2240*

Refer to NPO-20518, volume and number of this NASA Tech Briefs issue, and the page number.

Capture

...the light

With Photon's *BeamPro*filer System for profiling pulsed and CW laser beams.

- 1/2" CCD beam sensor
- Built-in variable attenuator
- *BeamPro*filer Image Capture Card
- Unequaled *BeamPro*filer software

NOW under \$4K!

www.photon-inc.com

PHOTON can help you solve ALL your light measurement challenges. Rapid characterization of laser diodes, fast collimation of fiber GRIN lenses, and accurate measurement of position and size of laser beams for scanning, printing, or telecom applications provide you with solutions to your photonics problems. Call PHOTON inc. today or visit our website to see how we can help you with your analyses.

PHOTON inc. Light Measurement Solutions
(408) 226-1000 or on the web at www.photon-inc.com.



PHOTON inc
Light Measurement Solutions

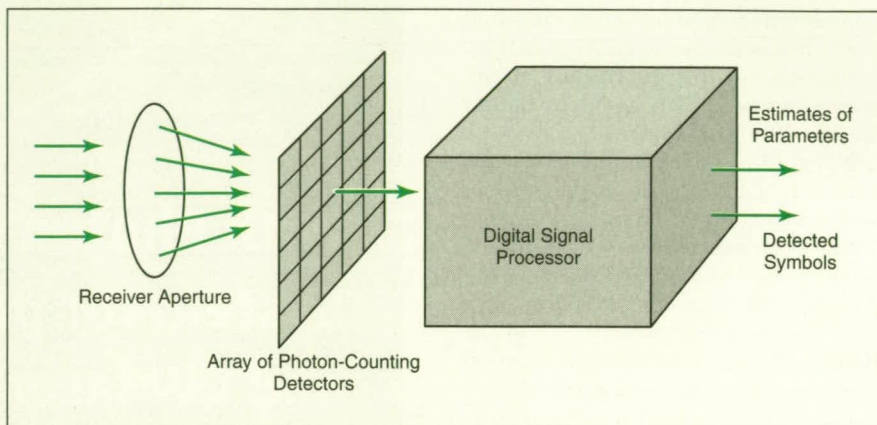
Adaptive Focal-Plane Detector Arrays for Optical Communications

Degradation of signals by atmospheric turbulence would be reduced.

NASA's Jet Propulsion Laboratory, Pasadena, California

Arrays of photon-counting detectors and associated digital signal processors have been proposed for receivers in optical communication systems in which the optical signals propagate through the atmosphere and are relatively weak upon reception. The digital signal processor would execute algorithms that adapt the overall responses of the receivers to the temporally varying photon counts of the individual detectors in such a manner as to reduce the deleterious effect of atmospheric turbulence.

In a system to which this proposal applies, the receiver would include a diffraction-limited telescope with an aperture diameter on the order of 1 to 10 m and a focal length on the order of twice the aperture diameter, and would be used to detect a signal at a wavelength around 1 μm . In the absence of atmospheric turbulence, most of the received



An **Array of Photon-Counting Detectors** would capture atmospheric-turbulence-induced random excursions of a received signal from a central, diffraction-limited focal spot. The digital signal processor would execute an algorithm that would weight the contributions of detectors in such a way as to reduce the relative contribution of background radiation.

signal power could be focused onto a single focal-plane detector no larger than the diffraction-limited spot size,

and background radiation from directions other than that of the signal source would be effectively spatially filtered out.

S-Series & Scimitar Diode-Pumped Nd:YAG Laser Systems

- ✧ 1-50kHz Q-Switched & CW Solutions
- ✧ Ideal for Marking, Drilling & Micromachining
- ✧ TEM₀₀ & Multimode Versions Available



Power Levels to
150W @ 1064nm



Power Levels to
50W @ 1064nm



Cutting Edge Optonics, Inc.

20 Point West Boulevard
Saint Charles, Missouri 63301
636.916.4900 voice • 636.916.4994 fax
www.ceolaser.com • info@ceolaser.com

In the presence of atmospheric turbulence, the phase of the optical signal arriving at a telescope becomes uncorrelated over distances greater than a coherence length that ranges from approximately 20 cm at night to as little as 2 to 4 cm during the day. The result is that the signal power is spread over a spot much wider than the diffraction-limited spot in the focal-plane, and the portion of signal power received at a given point in this wider spot tends to fluctuate on a time scale of about 10 to 100 ms. Hence, in order to capture most of the received signal power, it would be necessary to use a correspondingly larger-diameter detector, which, because of its greater field-of-view, would also capture more of the undesired background radiation.

In a system according to the proposal, a single large detector would be replaced by an array of smaller detectors, the photon-counting outputs of which would be fed to a digital signal processor (see figure). In the processor, the temporally varying photon counts from the detectors would be effectively weighted and combined by algorithms that assign greater weights to detectors receiving greater signal powers; thus, the contribution of undesired background radiation from detectors receiving less signal power would be reduced, the net effect being that the overall signal-to-noise ratio of the received signal is increased.

The detection algorithms have been formulated specifically for a communication system that uses *M*-ary pulse-position modulation in which the receiver attempts to determine which of *M* possible symbols has been received by observing the photon counts accumulated during each of the *M* time slots of a symbol period. It is assumed that the receiver is synchronized and, hence, "knows" the beginning and ending times of each symbol period as well as the time of arrival of each detected photon, and that these times and the associated photon counts can be stored for the limited amount of time needed for processing. It is also assumed that the photon-count outputs of the detectors are Poisson-distributed in time.

One of the algorithms utilizes continuous weighting of the counts from the individual detectors to implement an optimum array-detector receiver. However, this algorithm is not practical because the computational burden quickly becomes excessive as the number of detectors increases.

In the alternative simplified algorithm, continuous weighting is replaced by hard decisions on the selection of detectors from which the counts are to be considered at a given instant. This algorithm would implement a computationally simpler, suboptimum array-detector receiver. Computational simulations for representative cases have shown that the performance of the simpler suboptimum algorithm is almost equal to that of the more complex optimum algorithm, and that the improvement in performance over a single detector of diffraction-limited size would be equivalent to an increase in signal strength of about 5 dB under realistic operating conditions.

This work was done by Victor Vilnrotter and Meera Srinivasan of Caltech for NASA's Jet Propulsion Laboratory. For further information, access the Technical Support Package (TSP) free on-line at www.nasatech.com under the Electronic Components & Systems category.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to

Technology Reporting Office

JPL

Mail Stop 249-103

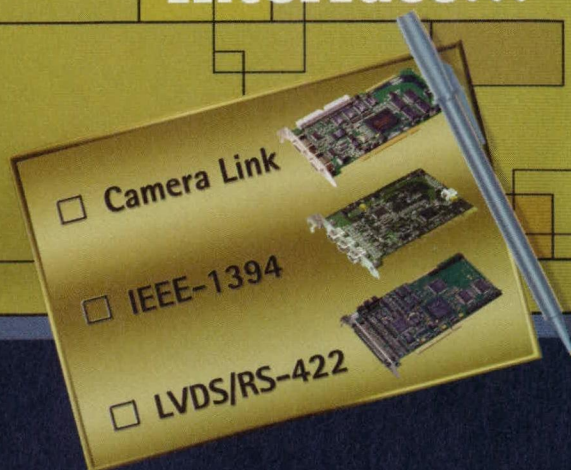
4800 Oak Grove Drive

Pasadena, CA 91109

(818) 354-2240

Refer to NPO-21041, volume and number of this NASA Tech Briefs issue, and the page number.

You choose the digital interface...



We provide the hardware

With Matrox Imaging, you have multiple choice when it comes to digital video acquisition.

Whether it's Camera Link™, IEEE-1394, LVDS or RS-422, Matrox Imaging has the hardware for the job. Our Meteor-II/Camera Link frame grabber and Meteor-II/1394 adapter board provide a simple, standard, high-speed connection to a new generation of digital industrial/scientific video cameras based on Camera Link or IEEE-1394, while the Meteor-II/Digital low-cost PCI frame grabber meets your traditional LVDS or RS-422 acquisition needs.

We also provide device-independent software to drive these digital solutions, offering a choice of Matrox Imaging Library (MIL)/ActiveMIL or MIL-Lite/ActiveMIL-Lite development toolkits for creating custom applications.

Interested in finding out more?

Visit www.matrox.com/imaging/ads/cam/nt
Call 1-800-804-6234 / +1-514-822-6020
E-mail imaging.info@matrox.com



Two-Axis Scanning Mirror in a Small Package

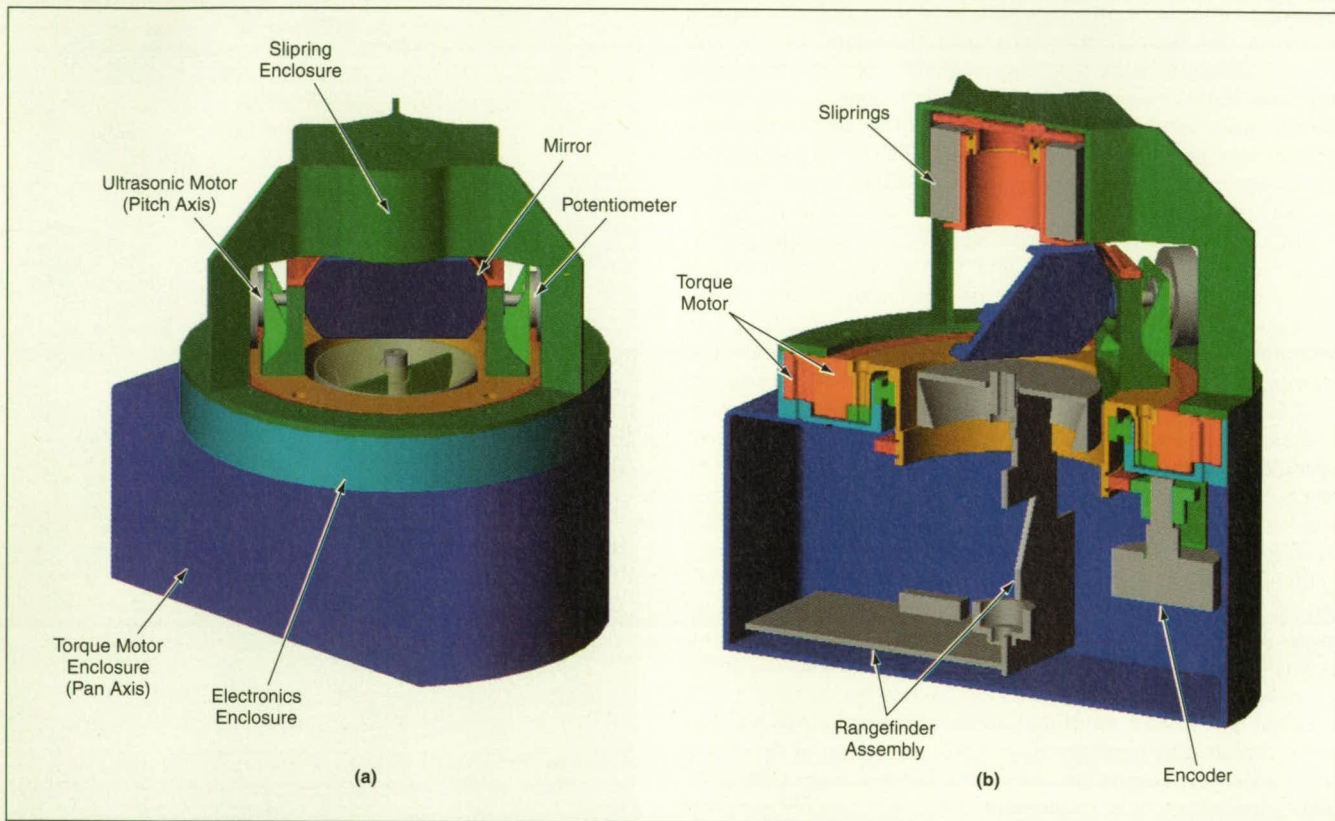
This compact, lightweight assembly enables scanning with high resolution and minimal backlash.

NASA's Jet Propulsion Laboratory, Pasadena, California

A compact two-axis scanning-mirror assembly (see figure) has been developed for use as part of a laser rangefinder on a robotic vehicle. The assembly is designed to enable scanning of the laser beam throughout the space surrounding the vehicle for three-dimensional mapping of objects in the vicinity.

The assembly includes a base that consists of a housing for the electronic drive circuitry and for the laser system of the rangefinder. Built into the top of the housing is the stator of a pan motor. An integral part of the stator mount is a domelike structure that supports the upper end of a pan rotor subassembly.

through-bore motor was chosen as the pan actuator. The open bore makes it possible to place part of the laser circuitry within the motor envelope, saving volume. The direct-drive, through-bore pan motor is capable of continuous pan motion and of angular positioning with relatively high resolution. Also, the



A Scanning-Mirror Assembly is shown intact (a) and in cross section (b).

Two-axis scanning-mirror assemblies of prior design exhibit two notable weaknesses, one being actuator backlash caused by gear-train slop. The present assembly contains direct-drive actuators that exhibit little or no backlash; as a result, the precision and resolution of beam positioning is limited only by the resolution of a feedback subsystem that is part of a control system operated in conjunction with the assembly. Moreover, because no gear trains are included, the number of moving parts is reduced and thus reliability is increased, relative to assemblies of prior design. The other notable weakness of prior designs is inability to pan continuously; the present assembly includes sliprings, which enable continuous panning.

An upper support bearing and the stator of a slipping subassembly lie within the domelike structure near its top.

The pan rotor subassembly consists of the rotor of the pan motor and an arch that is part of a tilt subassembly. The arch is tipped by the rotor of the slipping subassembly. The arch spans the open bore of the rotor of the pan motor. Between the sides of the arch is the mirror, supported by a bearing on each end of a tilt axle. The mirror is driven in tilt by an ultrasonic motor (USM) on one end of the tilt axle.

The overall design was driven by the desire to build the smallest unit possible for a given mirror size [≈ 1.4 in. (≈ 3.6 cm) high by ≈ 2 in. (≈ 5.1 cm) wide] while making it possible to orient the mirror as precisely as practicable. To this end, a

direct-drive design eliminates mass and volume that would otherwise be associated with a gear train.

One important advantage of a USM is passive braking; when power is not applied, it holds its position. Hence, the use of the USM as the direct driver on the tilt axis also eliminates mass and volume that would otherwise have been associated with an external brake that would have to be put on a gear train. In addition, a USM weighs less than does a conventional electric motor.

This work was done by Brett Kennedy of Caltech for NASA's Jet Propulsion Laboratory. For further information, access the Technical Support Package (TSP) **free on-line** at www.nasatech.com under the Machinery/Automation category. NPO-20904

Hot Dielectrics as Light Sources for TPV Devices and Lasers

Wavelength-selective emitters are combined with optical waveguides to form superemissive light pipes.

John H. Glenn Research Center, Cleveland, Ohio

Experiments have demonstrated the feasibility of using flame-heated refractory dielectric solid bodies as wavelength-selective sources of light for special applications; in particular, for powering thermophotovoltaic (TPV) devices and for pumping lasers. A refractory dielectric material suitable for this purpose is one that, when heated by a flame, emits intense light with a spectral peak or peaks at one or more visible and/or infrared wavelengths. For a given laser or TPV application, one would choose

such a material with an emission peak or peaks to match the corresponding laser absorption or TPV response peak(s). The emissive material can be in the form of a mantle or a felt, or it can be one of the chemical constituents of a solid crystal. To increase the effectiveness of a light source of this type, one can join a crystalline rod containing the emissive material with another rod (which serves as an optical waveguide) to form a device called a "superemissive light pipe" (SELP).

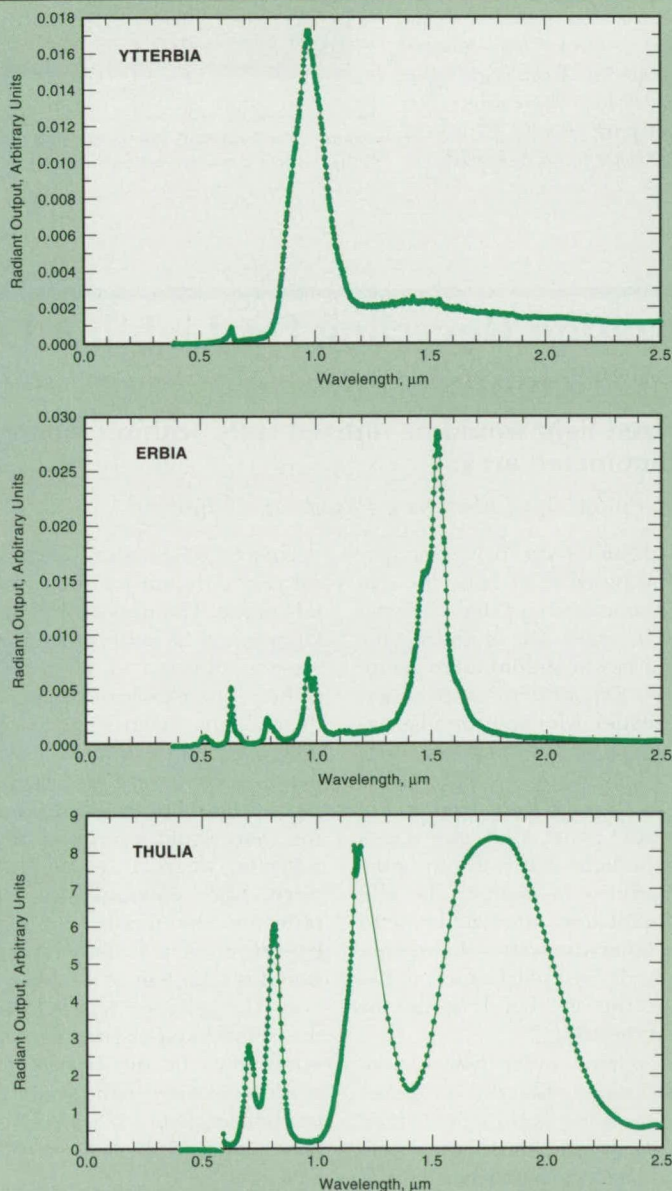


Figure 1. Emission Spectra of flame-heated mantles of three materials contain peaks that can be matched to absorption peaks of other materials to achieve transfer of energy in various applications.



Lasiris laser line thickness down to 5.5 μm

There's a fine line between guesswork and precision. With the Micro-Focus Series precision laser line generators, that line has been crossed. Capable of producing lines as thin as 5.5 μm, these evolutionary lasers reveal details you've never seen before—with remarkable accuracy. Which means inspecting tiny microchips, wafers, resistors, pins and semiconductor components just got a whole lot clearer—and more reliable. It's obvious.

MFL SERIES LASERS



- Thinnest line available: 5.5 μm at a precise working distance
- Uniform intensity distribution
- Exceptional thermal stability
- ESD-protected steel housing
- Fully-protected integrated laser diode driver



StockerYale
Simply brilliant ideas™

3549 Ashby Street
St-Laurent, Quebec H4R 2K3 Canada
T: (514) 335-1005 F: (514) 335-4576

1-800-814-9552

www.lasiris.com
sales@lasiris.com

Copyright © 2000 StockerYale.
All rights reserved.

In one set of experiments, ytterbia, erbium, and thulium were tested as candidate emissive materials in an effort to match the absorption peak of Nd³⁺ in neodymium: yttrium aluminum garnet (Nd:YAG) lasers and to match the photovoltaic response peaks of Si and GaSb TPV devices. Figure 1 shows the measured emission spectra of mantles of these materials heated by propane flames. Thulium could be chosen for pumping Nd:YAG lasers because its spectral peak at a wavelength of 818 nm lies in the absorption band (790 to 890 nm) of Nd³⁺. The erbium spectrum shows only weak emission in the Nd³⁺ absorption band but is well matched to the spectral response of GaSb devices.

SELPs made of various material combinations were tested in another set of experiments. For example, Figure 2 depicts a test setup for measuring the output of a GaSb photovoltaic cell under illumination from a SELP that comprised an emissive crystalline rod of erbium aluminum garnet (Er₃Al₅O₁₂, also known as "ErAG") bonded to a YAG light pipe. In one experiment in which the ErAG emit-

ter was heated to an estimated temperature of 1,350 °C by torches burning stabilized methacetylene propadiene (commonly called "MAPP gas"), the photovoltaic-power density was found to be 1.56 W/cm², corresponding to a photon-to-electron conversion efficiency of 29 percent. It has been estimated that if the emitter temperature were raised into the range of 1,500 to 1,600 °C, and if the conversion efficiency were to remain the same, then the photovoltaic-power density would rise to about 5 W/cm².

This work was done by L. G. DeShazer, A. S. Kushch, and K. C. Chen of Quantum Group, Inc., for Glenn Research Center. For further information, access the Technical Support Package (TSP) free on-line at www.nasatech.com under the Physical Sciences category.

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Commercial Technology Office, Attn: Steve Fedor, Mail Stop 4-8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-16678.

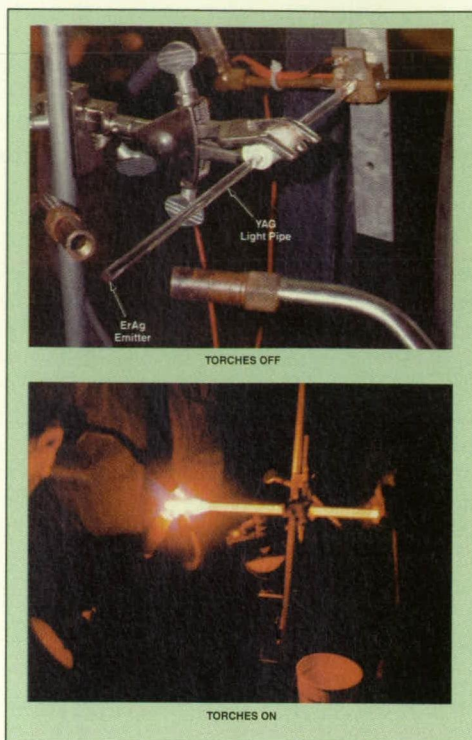


Figure 2. An ErAG/YAG SELP was tested for use in radiantly supplying power to a GaSb photovoltaic cell.

new! Plug & Play Camera Kit

\$1495 complete system

SILICON VIDEO® 2112 1.3 megapixel, 10 bit, progressive scan, monochrome or color, with a programmable resolution to 1288 x 1032 pixels.

PIXCI® D2X PCI Interface supplies power and programmable pixel clock for the camera. Trigger input for async reset.

XCAP-Lite Software provides camera control including sub-windowing/sampling, mirror & flip modes, RGB balance, and user-selectable pixel clock.

2 Meter Cable supplies power, pixel clock, and control.

**SILICON VIDEO® 2112
PIXCI® D2X
XCAP-Lite**

EPIX®

Buffalo Grove, IL USA
Tel. - 847 465 1818
Fax - 847 465 1919
epixinc.com/nt

©2001 EPIX, Inc.

Polarization Recycling for Lighting LCDs More Efficiently

Unpolarized light would be utilized fully, without enlargement of the illuminated area.

NASA's Jet Propulsion Laboratory, Pasadena, California

Two polarization-recycling techniques have been proposed to increase the efficiency of illumination of liquid-crystal display (LCD) panels. The motivation for this proposal lies in the inherent inefficiency of an LCD panel: For proper operation, illumination with polarized light is necessary, but a typical lamp generates unpolarized light. If one simply passes the lamp light through a polarizer on the way to the LCD panel, then one wastes the half of the light that is in the undesired polarization. To increase the efficiency of illumination, one would have to recycle the otherwise wasted light, converting the undesired polarization to the desired one; this is what is meant by "polarization recycling."

Unlike a related older polarization-recycling technique, the two proposed polarization-recycling techniques would not enlarge the cross section of the illuminating beam. (Such enlargement is a disadvantage in a typical application in which one seeks to illuminate a small panel.)

Figure 1 schematically depicts the optical configuration for the first proposed technique. The unpolarized light from a lamp would be concentrated by a reflector and directed to a polarizing beam splitter. The p-polarized light would pass through the beam splitter, while the s-polarized light would be reflected perpendicularly toward an LCD panel. The p-polarized light would strike a flat mirror, then would travel back to the lamp reflector, where it would be reflected twice. After emerging from the lamp reflector, the p-polarized light would pass through a half-wave retarder that would occupy half of the beam cross section. The half-wave retarder would cause the reflected p-polarized light to become s-polarized. In the beam splitter, this newly s-polarized light would be reflected perpendicularly toward the LCD panel, along with the originally s-polarized light.

For the portion of unpolarized lamp light that would hit the half-wave

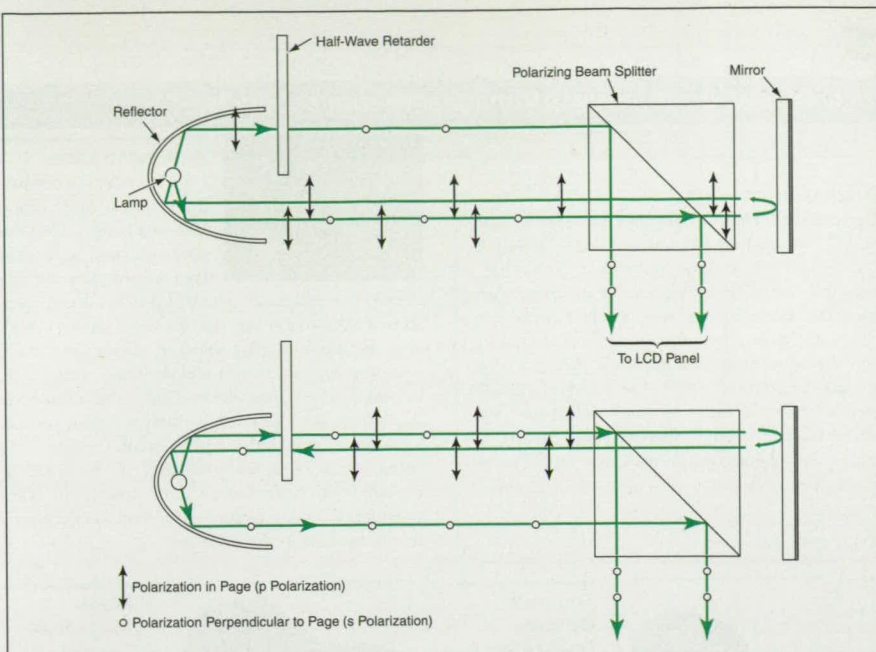


Figure 1. This **Optical Configuration for Polarization Recycling** would be suitable for illuminating a small panel facing perpendicularly to the optical axis of a lamp reflector.

retarder first, the end result would be the same, though the sequence of events would differ: After passing through the half-wave retarder, the initially unpolarized light would remain unpolarized until it reached the polarizing beam splitter. The p-polarized subpart of this part of the light would pass through the beam splitter, while the s-polarized subpart would be reflected perpendicularly toward the LCD panel. The p-polarized light would strike the flat mirror and would go back through the half-wave retarder, which would convert it to s-polarized light. Continuing along its path, this portion of s-polarized light would be reflected twice by the lamp reflector, and would finally be reflected perpendicularly, by the beam splitter, toward the LCD panel.

Figure 2 schematically depicts the configuration for the second proposed technique. Light from a lamp would reach a reflective polarizer; the p-polarized light would pass through to the LCD panel, while the s-polarized light would be reflected. The reflected s-polarized light

would pass through a quarter-wave retarder, becoming circularly polarized. The circularly polarized light would be reflected by a flat mirror and would go back through the quarter-wave retarder, which would cause this light to become p-polarized, as needed to join the originally p-polarized light in illuminating the LCD panel.

This work was done by Yu Wang of Caltech for NASA's Jet Propulsion Laboratory. For further information, access the Technical Support Package (TSP) **free on-line** at www.nasatech.com under the Physical Sciences category.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to

Technology Reporting Office

JPL

Mail Stop 249-103

4800 Oak Grove Drive

Pasadena, CA 91109

(818) 354-2240

Refer to NPO-20824, volume and number of this NASA Tech Briefs issue, and the page number.

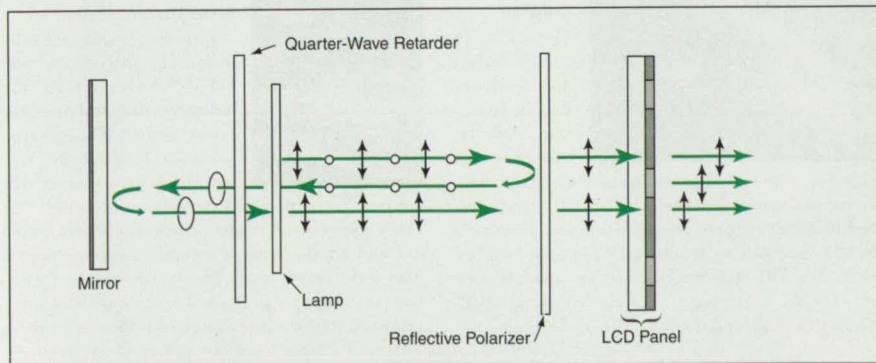


Figure 2. This **Alternative Optical Configuration** for polarization recycling could be suitable for illuminating a panel (e.g., a notebook-computer LCD panel) that would be on a direct optical path from a lamp.

Miniature Spectros

reliable & low cost
Instrumentation

UV-VIS-NIR

Fiber Optic SPECTROMETERS

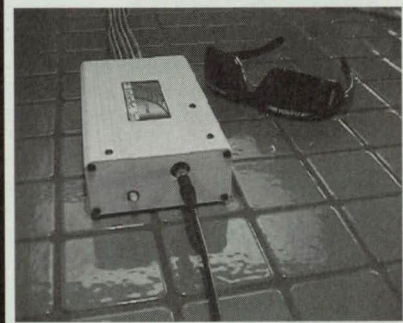
MEASURE Absorbance, Transmittance, Reflectance, Irradiance, Fluorescence, Chemical concentrations, Color $L^*a^*b^*$, Laser/Plasma emissions, & Thin Films.

Turnkey Systems >> SpectroColorimeters
SpectroRadiometers SpectroFluorimeters
Optical Spectrum Analyzers 200-1600nm
Multi-Beam UV/VIS Analysis 190-840nm

CCD/PDA detectors with built-in A2D!
Superb spectral imaging & optical res.
Acquire 2000 wavelengths in just 4ms.

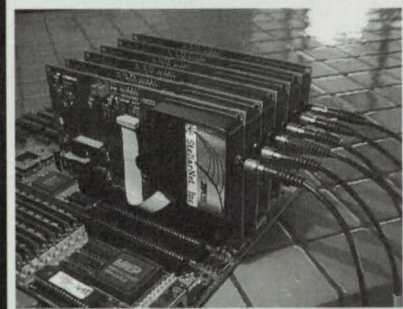
SpectraWiz® Software
Free Win95/98/NT Program & Drivers

EPP2000 Portable



connect to PC printer port
daisy-chain for multi-beam!

ISA2000 Plug-in



www.stellarnet-inc.com

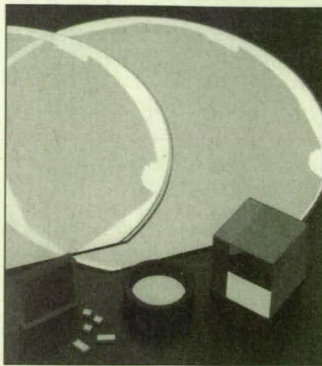


612 Shore Drive East
Oldsmar, FL 34677 USA
813-855-8687 / 813-855-2279 fax

New Products

For more information on the products below, go to www.ptbmagazine.com/products.

Product of the Month



Unique Polarizing Technology

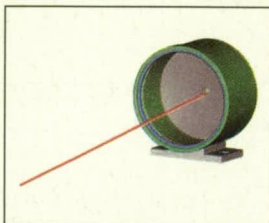
Meadowlark Optics, Frederick, CO, has formed an alliance with Moxtek, Urem, UT, to introduce the new VersaLight™ polarizer that draws on the latter's unique polarizing technology. Meadowlark says that VersaLight provides the broadest wavelength range and the widest field of view of any material currently on the market. Constructed of a thin layer of aluminum MicroWires™ on a glass substrate, the polarizer operates from the visible through the infrared, with what Meadowlark calls outstanding performance at the telecom wavelengths. The material can be shaped as needed, used in sheet format, or sandwiched between other components at normal incidence or at 45 degrees.



Small-Form-Factor Transmitters/Receivers

A new line of small-form-factor (SFF) dual transmitters and dual receivers

for optical communications comes from Stratos Lightwave LLC, Chicago, IL. Housed in an industry-standard SFF transceiver package with two LC fiber optic interfaces, each package contains either two transmitters or two receivers. They are available in 850-nm and 1310-nm versions for any data rate up to 2.7 Gb/s. A single SFF package can be ordered with the two transmitters or receivers having the same or different data rates and operating at the same or different wavelengths.



Compact Optical Transceiver

Kaiser Electro-Optics, Carlsbad, CA, introduces the Hyperscope™, a compact optical transceiver

for free-space optical communications. It can be provided in 850-nm, 1310-nm, and 1550-nm wavelengths. Its aperture range is 3 to 8 in., and obscuration area is about 0.5 percent. Field of view is about 1.5 minimum. Typical line-of-sight applications for the Hyperscope include backhaul, "last-mile" networks, or situations where laying of optical fiber is not feasible.



Air-Cooled Laser

Cutting Edge Optronics, St. Charles, MO, offers Repeat-a-Pulse, a 1064-nm diode-pumped air-cooled laser capable of delivering

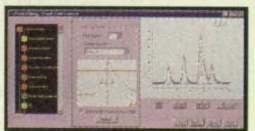
20-ns pulsewidths and up to 12 mJ at 1-to-30-Hz operation. Cutting Edge says that the beam quality is high and the pulse-to-pulse stability means that every pulse has the same width and the same energy. The Repeat-a-Pulse is available in TEM₀₀ and multimode configurations. The units are designed to be used in a constant-temperature environment. Cutting Edge recommends them for semiconductor manufacturing and repair operations, where identical pulses are essential. They are factory-sealed and maintenance-free, according to the company.



Multi-Megapixel Camera

DALSA, Waterloo, Ont., Canada, is offering the 4M25 multi-megapixel digital camera, designed for fast, very high-resolution

imaging. DALSA says the 4M25 is the first area-scan camera to combine 2048-x-2048 resolution and true 12-bit digital output at 25 frames per second. The camera's full-frame progressive-scan CCD has a 12-micron-square pixel format and a 100-percent fill factor. DALSA says it is especially good where inter-scene light variations exist. There are four camera outputs, and it comes with complete interface cable sets and Windows 95/98 control software.



Peak Fitting Module

OriginLab Corp., Northampton, MA, releases the PFM 6.1

peak fitting module, which the company says adds peak analysis functionality to Origin, the Windows-based scientific graphing and analysis software. OriginLab says that the PFM 6.1 provides an indispensable tool for spectroscopy, chromatography, and any other field requiring analysis and modeling of data with multiple peaks. The company credits the device's user-friendly interface with supporting highly interactive peak fitting. Data conditioning and adjustments to baseline, peak function, peak shape, or parameters can be done "on the fly" without having to initiate a new fitting session.



VCSEL Alignment Feature Add-On

Semiconductor Equipment Corp., Moorpark, CA, is adding two new features, a video image

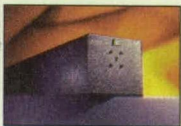
marker and a precision station, to the Model 410 and Model 860 Omni™ laser bonders, for enhancing precision during pickup and alignment of VCSELs with target sites on submounts such as TO headers. The optional video image marker creates and stores a fixed video overlay of crosshairs, in the form of a bit map for centering the VCSEL's emission point, as well as up to 10 different video patterns that can be superimposed on the submount on which the VCSEL is to be bonded. The precision station improves precision in VCSEL placement.



Modular Infrared Camera

Indigo Systems, Santa Barbara, CA, says that its new Phoenix™ infrared

camera family is designed to set new standards for performance and flexibility in nonvisible imaging solutions. Camera sensors are available in three spectral bands: near-IR, mid-IR, and longwave IR, with InSb, InGaAs, or QWIP snapshot focal plane arrays. Two resolutions are available: medium (320-x-256 pixels) and high (640-x-512 pixels). The system consists of a camera head and back-end electronics, which can be as much as 30 meters away from each other. All formats can produce 14-bit digital data at 40 Mp/s.



Diode-Pumped Industrial UV Laser

Coherent Laser Division, Santa Clara, CA, offers the AVIA 355-4500, a frequency-

tripled Q-switched diode-pumped solid-state UV laser. The new addition to Coherent's 355-nm AVIA line produces 4.5 W of average power at 25 kHz. The AVIA 355-4500 has variable repetition rates, adjustable "on the fly" from single-shot to 100 kHz, and has pulsewidths of less than 30 ns up to 60 kHz, with what the company calls excellent pulse-to-pulse stability. The AVIA is pumped by two field-replaceable aluminum-free active-area diode modules. Its design incorporates extra-cavity doubling and tripling, allowing the third-harmonic-generating crystal to be moved without altering the head's alignment.



Color Video Display

The TFT-M25 color video display from Polaris Industries, Atlanta, GA, measures

only 2 in. wide by 1.60 in. high, and 0.2 in. thick. The device has composite video (NTSC/PAL) and separate RGB video inputs. Display resolution is 480 wide by 234 high with a dot pitch of 0.105 wide by 0.161 high. The TFT-M25 weighs 25 g. The module runs off 12 VDC. Its viewing angle from left to right is 45 degrees, and up and down is 10 to 30 degrees.



Real-Time UV Power Monitor

Omron Electronics, Schaumburg, IL, introduces the F3UV, which it calls the industry's first real-time UV power monitor. The unit continuously monitors the output of UV light sources that

are used for curing and sterilization purposes. The F3UV comes in two models, one with a built-in amplifier and another with a separate amplifier/optical fiber with remote head. The former comes in a die-cast structure to prevent deterioration from UV exposure, and features a large LED for easy reading. The optical fiber head can withstand temperatures up to 300 degrees C, making it suitable for UV applications where high-temperature drying is required.

FREE INFORMATION REQUEST FORM

For quickest service:

Fax this form to (413) 637-4343

Use the online reader service center at www.nasatech.com (click on "Get More Information...FAST")

Or mail your completed form to
NASA Tech Briefs,
PO Box 5077, Pittsfield, MA 01203-9109.

Name: _____

Company: _____

Address: _____

City/St/Zip: _____

Phone: _____

Fax: _____

e-mail: _____

Please tell us below how *NASA Tech Briefs* has helped you solve a problem or been applied to your business/product line.

Do you currently receive *NASA Tech Briefs*? ☐ Yes ☐ No

If no, would you like to receive *NASA Tech Briefs*? ☐ Yes ☐ No

ARE YOU AN INSIDER?

Subscribe today to receive the INSIDER, a FREE e-mail newsletter from *NASA Tech Briefs*. The INSIDER features exclusive previews of upcoming articles...late-breaking NASA and industry news...hot products and design ideas...links to online resources...and much more.

☐ I want to be an INSIDER. Send my newsletter to the following e-mail address:

Name _____

Company _____

I also want to receive special-focus e-newsletters on the following technology topics: (check all that apply)

- | | |
|----------------------------------|--|
| <input type="checkbox"/> CAD/CAE | <input type="checkbox"/> Fiber Optics/Communications |
| <input type="checkbox"/> Lasers | <input type="checkbox"/> Test & Measurement |
| <input type="checkbox"/> Optics | <input type="checkbox"/> Imaging/Cameras |
| <input type="checkbox"/> Sensors | |

For fastest service, sign up online at www.nasatech.com. Look for this button at the top of the home page > > > > > >

**FREE
NEWSLETTER**

Circle the numbers below to receive more information about products and services featured in this issue.

401	402	403	404	405	406	407	408	409	410
411	412	413	414	415	416	417	418	419	420
421	422	423	424	425	426	427	428	429	430
431	432	433	434	435	436	437	438	439	440
441	442	443	444	445	446	447	448	449	450
451	452	453	454	455	456	457	458	459	460
461	462	463	464	465	466	467	468	469	470
471	472	473	474	475	476	477	478	479	480
481	482	483	484	485	486	487	488	489	490
491	492	493	494	495	496	497	498	499	500
501	502	503	504	505	506	507	508	509	510
511	512	513	514	515	516	517	518	519	520
521	522	523	524	525	526	527	528	529	530
531	532	533	534	535	536	537	538	539	540
541	542	543	544	545	546	547	548	549	550
551	552	553	554	555	556	557	558	559	560
561	562	563	564	565	566	567	568	569	570
571	572	573	574	575	576	577	578	579	580
581	582	583	584	585	586	587	588	589	590
591	592	593	594	595	596	597	598	599	600
601	602	603	604	605	606	607	608	609	610
611	612	613	614	615	616	617	618	619	620
621	622	623	624	625	626	627	628	629	630
631	632	633	634	635	636	637	638	639	640
641	642	643	644	645	646	647	648	649	650
651	652	653	654	655	656	657	658	659	660
661	662	663	664	665	666	667	668	669	670
671	672	673	674	675	676	677	678	679	680
681	682	683	684	685	686	687	688	689	690
691	692	693	694	695	696	697	698	699	700
701	702	703	704	705	706	707	708	709	710
711	712	713	714	715	716	717	718	719	720
721	722	723	724	725	726	727	728	729	730
731	732	733	734	735	736	737	738	739	740
741	742	743	744	745	746	747	748	749	750
751	752	753	754	755	756	757	758	759	760
761	762	763	764	765	766	767	768	769	770
771	772	773	774	775	776	777	778	779	780
781	782	783	784	785	786	787	788	789	790
791	792	793	794	795	796	797	798	799	800
801	802	803	804	805	806	807	808	809	810
811	812	813	814	815	816	817	818	819	820
821	822	823	824	825	826	827	828	829	830
831	832	833	834	835	836	837	838	839	840

WORLD PERFORMANCE LEADERSHIP

by



MICRO-EPSILON

in

LINEARITY RESOLUTION STABILITY SPEED

EDDY CURRENT SENSORS

eddyNCDT



- Ranges 0.5 - 80 mm
- Resolution 0.05 μm
- Linearity $\pm 0.2\%$ FSO
- Frequency 100 kHz
- Temperature stability $\pm 0.01\%$ FSO/ $^{\circ}\text{F}$

LASER CCD SENSORS

optoNCDT

- Ranges 2 - 700 mm
- Resolution 0.1 μm
- Linearity $\pm 0.03\%$ FSO
- Frequency 10 kHz
- Temperature stability $\pm 0.001\%$ FSO/ $^{\circ}\text{F}$



CAPACITIVE SENSORS

capaNCDT



- Ranges: 0.05 - 30 mm
- Resolution 0.0001 μm
- Linearity $\pm 0.2\%$ FSO
- Frequency 6 kHz
- Temperature stability of sensitivity $\pm 0.0015\%$ $^{\circ}\text{F}$

Full Line of Displacement Sensors - online
www.micro-epsilon.com

MICRO-EPSILON

Raleigh, NC 27617-7419

Tel.: 919/787-9707 Fax: 919/787-9706

e-mail: me@micro-epsilon.com

Reader Forum

Reader Forum is dedicated to the thoughts, concerns, questions, and comments of our readers. If you have a comment, a question regarding a technical problem, or an answer to a previously published question, post your letter to Reader Forum on-line at www.nasatech.com, or send to: Editor, *NASA Tech Briefs*, 317 Madison Ave., New York, NY 10017; Fax: 212-986-7864. Please include your name, company (if applicable), address, and e-mail address or phone number.

I'm researching piston loads and forces, using kinematic equations backed up by analytical software. I'm looking for a mathematical formulation on piston skirt loads. The general equations found in engineering books are only approximate, and do not delve deeply enough into the explicit nature of the "rocking effect." Any assistance would be appreciated.

Stephen Golya
glyztn@aol.com

I read with interest the brief in the March issue of *NASA Tech Briefs* entitled "Metal-Supported Catalyst Beds for Reacting CO_2 With CH_4 " by Gerald Voecks of NASA's Jet Propulsion Laboratory. This work could be the centerpiece of technology in developing partially recyclable fuels for fuel cells that could be used for clean-burning future automobiles. It may be a stretch now, but what better source for hydrogen than water? I would like to hear comments relative to, and expanding upon, the concept developed by JPL.

Michael Horvath, Jr.
michaelh@tauberoil.com

(Editor's Note: Michael, there is more information available on this technology through the Technical Support Packages section of our Web site at www.nasatech.com/tsp. Click on the Materials category, and you'll find the associated information.)

I can find wear rate data on Type 3 hard anodized coating, but I am trying to find wear data on Type 2 architectural anodized coating. Does anyone know where I can find such data? I'm looking for data on both sealed and unsealed Type 2 anodize. Thanks.

Steve Gonya
sgonya@stny.rr.com

I'm looking for a supplier of Peltier Cooling/Thermal Electric Units (TEUs) and some information on the temperatures they can withstand.

Robert Lehman
robert.lehman@autolivASP.com

(Editor's Note: Robert, here's a response from a fellow NASA Tech Briefs reader regarding your request.)

The standard temperature limit is 80°C , but there is also a high-temperature version that will survive up to 200°C . The coatings are very unforgiving about overheating. They are made from low-melting alloys and will simply melt down. Low temperatures are no problem as far as I know. I've cooled down to -80°C with Peltiers. You may also find additional information at www.melcor.com. Hope this helps.

Leif Kjellberg
leif.kjellberg@acreo.se

You've got one chance to get it all.

**WHY RISK IT
ON ANYTHING LESS
THAN A SONY?**

SIR-1000W/SIR-1000i

Wideband Digital Data Recorder
/ICP® - video/analog/digital data

Sony digital data recorders give you incredible performance and superior reliability in lightweight, compact configurations that fit almost anywhere.

Our SIR-1000 series captures critical analog and digital data (or analog and synchronized video data with our optional video card) at speeds up to 160kHz and 24 Mb/sec for as long as 2 full hours (32 hours max. at lower bandwidths). Utilizing the Advanced Intelligent Tape standard, they can store up to 25 Gbytes (non-compressed) on a single AIT cartridge.



For situations demanding lower bandwidth, but equally rugged performance and reliability, Sony provides the PC200AX series.

These portable, DAT-based digital data recorders have bandwidth from DC to 20kHz, can be configured up to 128 channels, and allow recording times up to 6 hours.

Compact Size:
13.4" wide,
10.2" deep, 4.5" high

And with their easy-to-use WindowsNT®-based software, Sony digital

data recorders make your data as easy to analyze as it is to record.

So, if you only have one chance to get it right, get the digital data recorder that won't let you down. Call us at 1-949-770-8400, or visit us at www.sonypt.com.

ICP is a registered trademark of
PCB Piezotronics, Inc.

For More Information Circle No. 527

see what's
happening

PRECISE
REPEATABLE
RELIABLE
POSITION
SENSING SYSTEMS

KAMAN



K μ DA is micro-processor based and software controlled to solve almost any position measurement problem. Easy push-button calibration, interchangeable sensors, and the ability to save and recall specific sensor-target calibration configurations make K μ DA ideal for the lab environment. Inductive technology is noncontact and immune to dust, fluids and color.

See us at Sensors Expo Booth 1334

For More Information
Circle No. 411

Who's Who at NASA

Anna McGowan, Morphing Project Program Manager, Langley Research Center

Anna McGowan is an aerospace engineer who serves as Program Manager for the Morphing Project at NASA's Langley Research Center in Hampton, VA. The project is focused on finding new applications for "smart" materials, as well as finding methods for applying those materials, specifically in aircraft.



NASA Tech Briefs: What is the mission of the Morphing Project?

Anna McGowan: The Morphing Project division is looking 20 years or further into the future and asking what airplanes are going to look like in 20 years, and what technologies we need to be researching today to make that possible. If we want airplanes that are extremely lightweight, maybe we need structures and materials that are more like bones, or very lightweight, porous materials that are still very strong. We want wings that can handle rocks flying at them, or other damage. Can we make things that self-heal — something that you can shoot a bullet through and it heals? We are not focusing on a specific vehicle, but rather different technologies that would be applicable to a variety of different structures.

NTB: Could you explain what makes the materials you work with "smart"?

McGowan: Smart materials actually respond to a stimulus and you can control that response to your benefit. So, as an example, if you need to control vibration, you can take one of these materials that vibrates, you can control it to vibrate in the opposite direction your wing is vibrating, and you therefore control wing vibration. That's why they're called smart materials. They respond in a reproducible manner. For example, when you apply five volts, it moves six inches. Some of these materials are vibrational, which means they work better at higher frequencies. Others are more static — they move slowly but are very strong and can bend huge structures very easily. For the materials

that move, you can compare those to non-smart materials like steel or wood. If you apply heat to steel or wood, they don't move. They don't do anything except maybe melt or burn.

The idea is that basically, today, to make things move, we need gears, hydraulics, pumps, cables, etc. Here, you would not need that. All you would need is the smart materials and stimuli like heat, electricity, or magnetism.

NTB: How many different types of smart materials are you working with?

McGowan: There are actually far too many to name because there are so many different variations. Nickel titanium is a very common shape-memory alloy, but you can add different elements to change different aspects of each alloy. We've mixed and created a lot of different materials, although we tend to stay with the ones we know work very well. Langley is, for all of NASA, the Center of Excellence for structures and materials, so we can create new materials here, modify existing materials, and build and test a lot of different and eccentric structures in a lot of different ways.

NTB: Have you discovered any unexpected applications for these materials that may cross over into the public sector?

McGowan: Without a doubt, we've found uses for these materials. I'll give you a classic example. The THUNDER Actuator is an actuator that was created, developed, and patented right here at Langley. It is now considered commercial and off the shelf. It is made from smart material. It's being used in all sorts of applications, including medical and pumping applications. A lot of these different materials can be tailored for medical applications, and vibration suppression in washing machines, cars, trucks, and buses. If you could shave five percent off the drag of a truck, you'd save millions of dollars in fuel.

A full transcript of this interview appears on-line at www.nasatech.com/whoswho. Ms. McGowan can be reached at a.r.mcgowan@larc.nasa.gov.

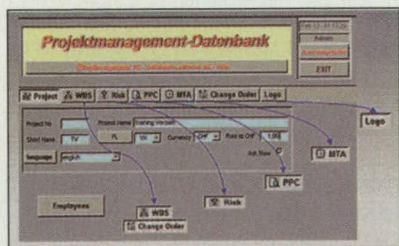
Technologies of the Month

Sponsored by **yet2.com**

For more information on these and other new, licensable inventions, visit
www.nasatech.com/techsearch

Project Management Application Provides Comprehensive Overview, Increased Efficiency

Hans Mechler, F. Hoffmann La Roche Ltd.



one that integrates the whole project in one application. F. Hoffmann La Roche Ltd. and Triplan have developed a comprehensive project management software tool that integrates all information into a single database that is used to update and track every aspect of a project, including work breakdown structure, cost control, change order management, risk assessment, project process control, and milestone trend analysis.

This software tool holds enormous benefits for virtually any industry, especially those with complicated projects that require cooperation across organizational or hierarchical units.

Get the complete report on this technology at:
www.nasatech.com/techsearch/tow/roche.html

New LCD Technology Enhances Display Viewing

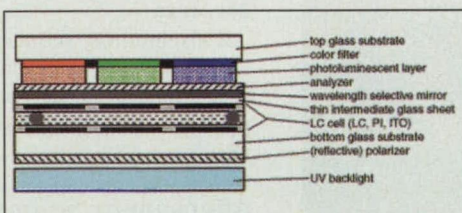
Tony Cupolo, Perimeter Technology, Inc.

Liquid crystal displays (LCD) are found virtually everywhere today — in personal digital assistants, cell phones, and laptops. This technology is a novel display architecture that uses photoluminescence to turn an LCD into a brighter, more energy-efficient, easier-to-see display.

The basic idea is to turn what is a transmissive or transreflective display into an emissive one (ELCD). That is, to use an active or passive matrix LCD display to activate a photoluminescent display screen that offers better color purity, better contrast, a wider viewing angle, and reduced power consumption.

Low-resolution display opportunities are widespread, including industrial monitors, test and medical equipment displays, and some instrumentation displays.

Get the complete report on this technology at:
www.nasatech.com/techsearch/tow/cupolo.html



Improved Methods for Sealing and Lubricating Dynamic Groove Bearings

Marc Wolfs, Philips

Dynamic groove bearings have become popular with design engineers because of their simplicity, reliability, and virtual absence of mechanical wear. Dynamic bearings usually consist of two parts that move in close proximity relative to each other, separated by a thin film of lubricant under pressure. This technology features three new sealing methods and an active lubricant reservoir devised by Philips.

The first of the three sealing methods features an elastic O-ring held in place by a flange and rim on the two parts. The second involves manufacturing the inner bearing part with an annular raised portion and the rotating outer bearing part with an oblique surface. The third features a V-shaped annular recess in the outer bearing part that angles out from the inner bearing surface. The lubricant reservoir ensures the continuous, effective containment and distribution of lubricating fluid within the bearings.

Philips' dynamic groove sealing structures and lubricant reservoir are suited for virtually any bearing application that requires continuous motion, such as disk drives, laser scanners, CD and DVD systems, rotating magnetic recording and playback heads, and spindles.

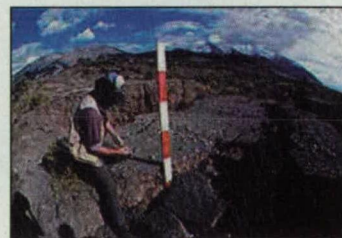
Get the complete report on this technology at:
www.nasatech.com/techsearch/tow/philips.html

Satellite/Internet-Based Detection and Notification System

Jack Baxter, Baxter Technologies

This technology is an early detection and notification system that takes advantage of global satellite technology and the Internet. The system comprises remote environmental sensors that transmit data via satellite to a database server, which, in turn, can provide data through any number of available technologies, including computer, e-mail, telephone, pager, or the Internet.

The sensors can be modified to track environmental conditions such as hydrocarbon and toxin concentrations, atmospheric activity and water temperature, and animal migration. It also can detect and monitor airborne chemical, biological, and nuclear substances. This system is useful for monitoring or research in areas hampered by environmental conditions or remoteness.



Get the complete report on this technology at:
www.nasatech.com/techsearch/tow/baxter.html



Commercialization Opportunities

Pressure Sensor Based on Measurement of Vibration Damping

By slight modifications of the resonator and drive circuit, it may be possible to produce a device with the upper limit of 10 atm and the lower limit to $<10^{-6}$ torr.

(See page 34.)

Integrated Capacitive Wheel-Contact Sensors

Features include low power, light weight, and simplicity. These sensors are integrated into a wheel and serve to indicate contact or proximity with the ground for a small robotic vehicle.

(See page 35.)

Rare-Earth Optical Temperature Sensors

These sensors are suitable for use in harsh environments at temperatures above the maximum 1,700 °C that Pt/Rh thermocouples can withstand.

(See page 36.)

Digitally Programmable Analog Membership-Function Circuits

This invention takes advantage of both the programmability of digital circuitry and the speed and compactness of analog circuitry. The circuits are to be used in fuzzy-logic systems.

(See page 42.)

Lithium Alkoxide Electrolyte Additives for Lithium-Ion Cells

Electrolyte additives extend the lithium-ion cell operating limits from -20 °C down to -40 °C. Prototype cells that contained this electrolyte showed high charge and discharge capacities, capability to discharge at high rates, and high cycle lives at both low and room temperatures.

(See page 52.)

Filled Skutterudites as Thermoelectric Materials

These have shown promise as semiconducting materials with superior thermoelectric properties at temperatures up to at least 650 °C.

(See page 56.)

Expendable Composite-Layup Dies From Rapid-Prototype Masters

This method reduces the time and cost associated with the production of small quantities of composite-material parts that have complex shapes.

(See page 57.)

Atmospheric Source of Atomic Oxygen for Cleaning Paintings

A portable apparatus operates at atmospheric pressure to generate a beam of monatomic oxygen for restoring paintings damaged by people or the elements. The apparatus and the method can be of interest to art museums, galleries, auctioneers, and professionals working in art restoration.

(See page 61.)



Data Propulsion

Do you need custom solutions for telemetry, mapping or remote sensing?

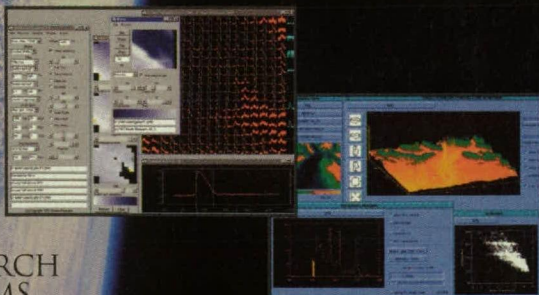
- Create robust applications in far less time using IDL than with other traditional programming languages

Does your data come from a missile, a satellite, an aircraft or a lab?

- Handle large multi-dimensional data
- Read and write virtually any data
- Display 1D, 2D, 3D or even 4D visualizations and interact with your data in real time

Put yourself in the cockpit.

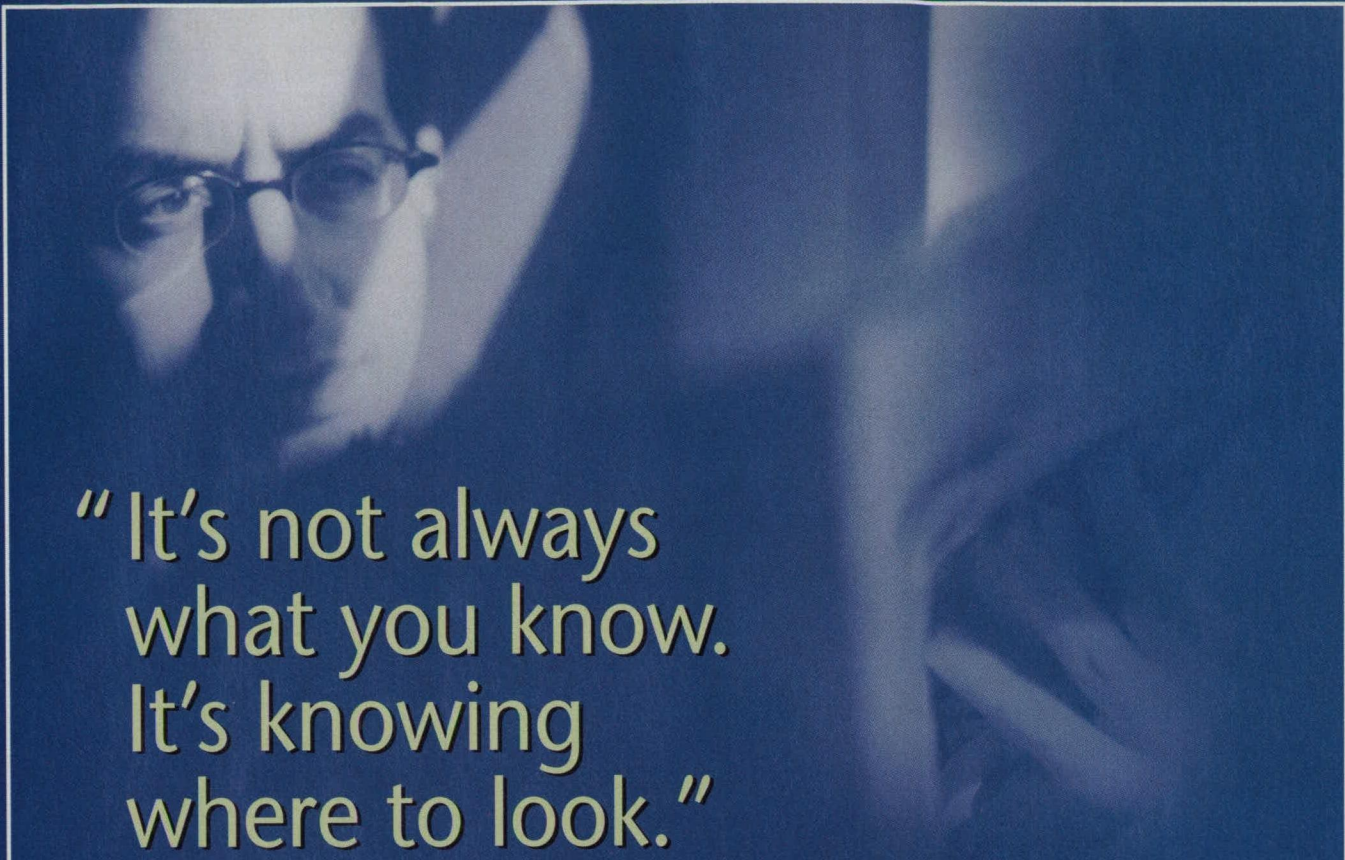
- Develop a user interface in IDL or... use IDL as an ActiveX control
- Call C, C++, or FORTRAN code, or... call IDL from your existing application
- Deploy your solution on... Windows, UNIX, Linux and Macintosh



Telephone: 303.786.9900
info@ResearchSystems.com

IDL is a registered trademark of Research Systems, Inc.
All other marks are the property of their respective owners.

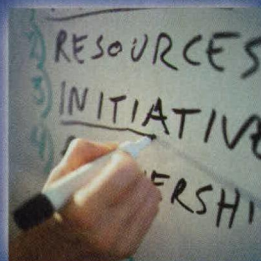
Make IDL your co-pilot:
www.researchsystems.com/ntb



"It's not always
what you know.
It's knowing
where to look."

**yet2.com. The world's leading
Internet-based technology marketplace.**

yet2.com is an interactive tech marketplace that enables you to think outside the box. Expand your technology horizons. We offer a fast, convenient, easy-to-navigate way to look at hundreds of licensable technologies from leading international organizations and individual inventors alike. Every week we feature a *Tech of the Week* so viewers can learn about the coolest new technologies available for licensing. Tell us what you're looking for and we'll e-mail you when relevant abstracts get listed. Or list your own technology for the world to see.



yet2.com is a rich, dynamic arena where diverse industries meet and ideas cross-pollinate. It's the one place where inventors and users come together. Where the possibilities are endless and you can actually see the future.

yet2.com

You can also view yet2.com's *Tech of the Week* by logging onto nasatech.com/techsearch

Application Briefs

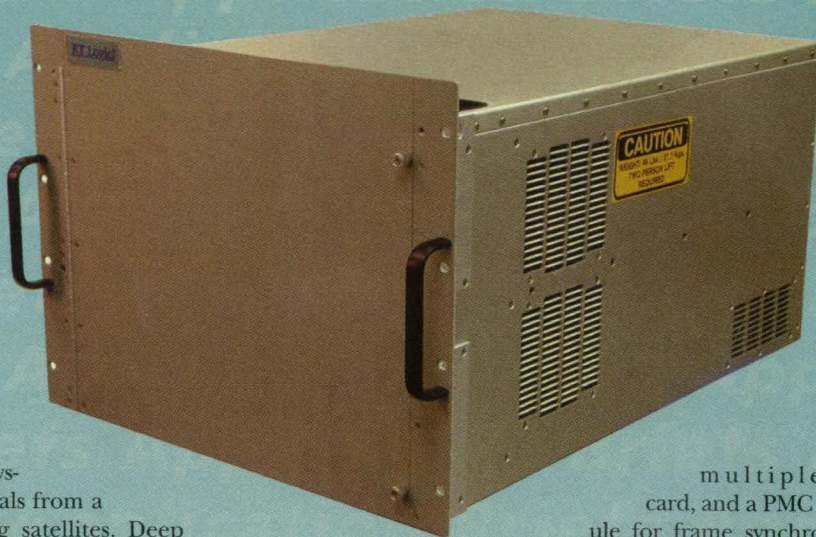
Telemetry Processor Upgrades Deep Space Network

Telemetrix™ 505 telemetry processor
RT Logic
Colorado Springs, CO
719-598-2801
www.rtlogic.com

NASA's Jet Propulsion Laboratory (JPL) in Pasadena, CA, has recently upgraded the downlink telemetry processing for the Deep Space Network, using RT Logic's Telemetry Processor (TLP). The system processes a wide array of downlink signals from a variety of interplanetary and Earth-orbiting satellites. Deep Space Network is NASA's international network of antennas located at Goldstone, CA; Madrid, Spain; and Canberra, Australia.

The TLP performs digital signal processing and data routing, including Viterbi Decoding, time tagging, frame synchronization, and Reed/Solomon decoding. It routes data to and from external data decoders, and enables archival of acquired telemetry. The processor hosts JPL-developed software for further data processing required for specific missions.

Hardware for the TLP includes a 12-slot VME chassis, two PowerPC processors running the VxWorks operating system, a 9-GB hard disk drive, a 6U VME Viterbi decoder/data



multiplexer card, and a PMC module for frame synchronization. RT Logic configured all of the hardware, integrated the software and hardware, created system documentation, and conducted acceptance testing.

An initial contract was awarded by JPL in October 1999 with requirements for a prototype TLP and three production units. Delivery of the prototype occurred in December 1999, and the three production TLPs were delivered in October 2000. JPL also exercised a 28-unit production option for upgrades to the ground systems at Goldstone, Madrid, and Canberra.

For More Information Circle No. 748

Power Supplies Maintain Space Station Electronics

Xantrex Model XHR power supplies
Xantrex Technology
Vancouver, BC, Canada
604-422-2759
www.xantrex.com

NASA launched on the Space Shuttle Discovery earlier this year programmable power supplies for testing and repairing electronic equipment on the International Space

Station (ISS) and visiting shuttles. The ISS's main power is generated from a solar photovoltaic array at 120 volts DC, which the power supplies will convert to variable voltage levels required to test the electronic equipment, including avionics. The system is part of a portable electronics workbench that can be moved anywhere within the zero-gravity station.

At a cost of approximately \$10,000 per pound to launch materials into orbit, weight is crucial. To shave more than four pounds off the weight of the 1,000-watt programmable power supplies, Xantrex switched several components from steel to lightweight aluminum. The conversion of materials also prevents condensation and rust in the high-humidity atmosphere of the ISS. A simple on/off switch was developed to allow the supply to handle the 120V DC input. The input connector was made to conform to space station standards, and bigger knobs were added for ease of use in a zero-gravity environment.

The customization process included pre-flight vibration/shake testing to ensure the power supply could withstand the G forces generated during launch. The unit also was tested at extreme hot and cold temperatures.

For More Information Circle No. 747





Fiber-Optic Transducers for Distributed Sensing of Volatiles: An Optical Nose

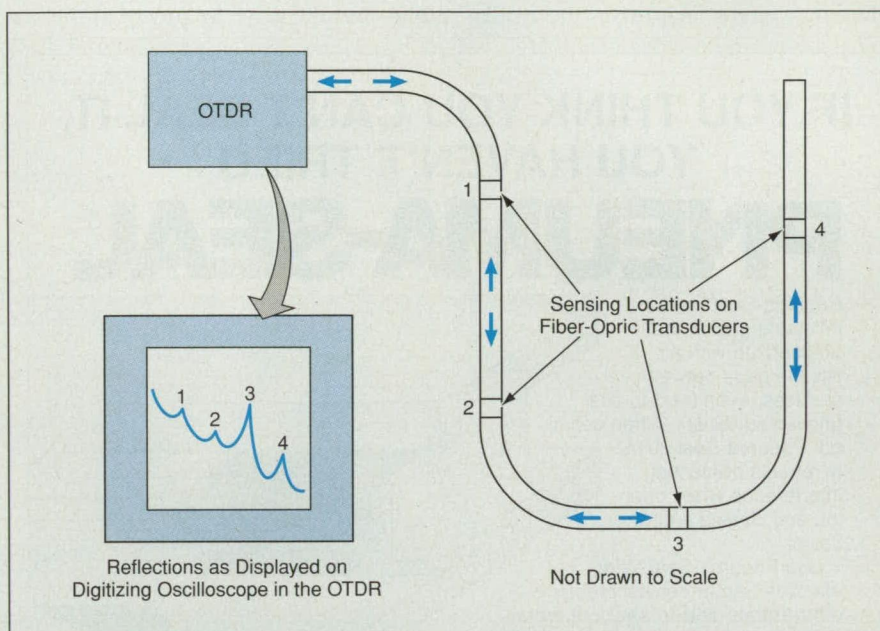
Volatiles would swell polymers on optical fibers, inducing changes in indices of refraction.

NASA's Jet Propulsion Laboratory, Pasadena, California

The term "optical nose" refers to a fiber-optic chemical sensor of a type that has been proposed to enable distributed measurement of the concentrations of volatile compounds. Optical noses should not be confused with electronic noses, which are single-point sensors based on chemical-induced variations of the electrical resistances of carbon-black/polymer composite films. Optical noses could enable rapid measurement of gas mixtures (e.g., volatile compounds in air) at multiple sensing locations along their lengths, which could be of the order of kilometers. Optical noses could function well in locations where audio- and radio-frequency electromagnetic interference renders electronic noses ineffective. Moreover, it may be easier to fabricate optical noses than to fabricate electronic noses because it would not be necessary to handle carbon black.

An optical nose (see figure) would include a commercially available handheld optical time-domain reflectometer (OTDR) and a fiber-optic transducer, which would typically be prepared as follows: An optical fiber would be coated with a polymer that swells when it absorbs a volatile compound. The outer surface of the polymer would be coated with a gas-impermeable film. At designated sensing locations along the optical fiber, the impermeable film would be removed in patterns to form half-circumference, millimeter-wide notches through which gases could enter the polymer.

The absorption of one or more volatile compounds through the notch at a given sensing location would give rise to asymmetric swelling of the polymer; the asymmetric swelling would engender shear stress which, in turn, would cause local variation in the index of refraction of the fiber. (Optionally, the notches could extend the full circumference, in which case the swelling and the resulting shear-stress pattern would be symmetric. However, the asymmetric configuration is preferred be-



Volatile Compounds in the Air would give rise to local variations in the index of refraction at sensing locations along an optical fiber. The locations and magnitudes of these variations would be measured by use of optical time-domain reflectometry.

cause the shear stress and the associated change in the index of refraction would be greater.)

The OTDR would launch picosecond laser pulses into the optical fiber at one end. The index-of-refraction variations associated with the presence of volatile compounds at the notches would cause part of the incident laser light to be reflected. The OTDR would make time-resolved measurements of the intensity of the reflected laser light. For a given reflected pulse, the location of the corresponding sensing notch could be inferred from the measured round-trip pulse travel time.

It should be possible to construct arrays of optical noses for discrimination among different volatile compounds. Each fiber-optic transducer in such an array would be coated with a different polymer, which would be chosen so that the index-of-refraction response of this transducer to different volatile compounds of interest would differ from the corresponding responses of the other

transducers. For automated or semiautomated operation, the readouts of all the transducers in the array could be digitized, then processed by principal-component-analysis and pattern-recognition algorithms to discriminate the volatile compounds of interest.

This work was done by Adrian Ponce and Dmitri Kossakovski of Caltech for NASA's Jet Propulsion Laboratory. For further information, access the Technical Support Package (TSP) free on-line at www.nasatech.com under the Physical Sciences category.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to

*Technology Reporting Office
JPL*

*Mail Stop 249-103
4800 Oak Grove Drive
Pasadena, CA 91109
(818) 354-2240*

Refer to NPO-21105, volume and number of this NASA Tech Briefs issue, and the page number.

Pressure Sensor Based on Measurement of Vibration Damping

Attributes include high resolution, wide dynamic range, compactness, and low power.

NASA's Jet Propulsion Laboratory, Pasadena, California

A compact, low-power device measures pressure via the pressure-induced damping of oscillation of a small mechanical resonator. To achieve compactness and low mass — and thus low-power consumption — the resonator is micro-machined out of silicon. In addition to the resonator, the device includes an electronic circuit that drives the oscillation and effectively measures the resonance quality factor (Q), which is inversely proportional to the rate of damping.

The drive circuit generates a drive voltage that alternates at the frequency of the mechanical resonance. The circuit tracks the mechanical resonance to maintain the drive frequency at the resonance frequency, even when the resonance frequency drifts gradually with time or with changes in temperature.

The drive circuit generates a drive voltage that alternates at the frequency of the mechanical resonance. The circuit tracks the mechanical resonance to maintain the drive frequency at the resonance frequency, even when the resonance frequency drifts gradually with time or with changes in temperature.

The drive voltage is applied to electrostatic-deflection electrodes to excite and maintain the oscillation. The circuit includes a feedback loop that measures the amplitude of the oscillation and adjusts the drive voltage to maintain the oscillation at a preset amplitude.

At a given time, the magnitude of the drive voltage needed to maintain the preset amplitude of oscillation depends on the rate of damping and thus on the pressure at that time. Accordingly, the magnitude of the drive voltage developed by the feedback loop is sampled and taken as an indication of pressure.

The overall sensitivity of the device depends partly on the intrinsic Q of the resonator (the Q that the resonator would exhibit during operation in a perfect vacuum) and partly on the sensitivity of the drive circuit. Inasmuch as the intrinsic Q of a micromachined resonator like the one used in this device typically ranges from 100,000 to 200,000, high sensitivity to pressure can be achieved readily.

The device can be designed to have a wide dynamic range. For example, an early version of the device was found to indicate pressures in the range of 10^{-6} to 10^{-2} torr (approximately 10^{-4} to 1 Pa) with nearly linear response over a large part of that range (see figure). It should be possible to extend the upper limit of this pressure range to as much as 10 atm (approximately 1 MPa) and the lower limit to $<10^{-6}$ torr ($<10^{-4}$ Pa) by slight modifications of the resonator and drive circuit. The pressure-measurement resolution is limited only by the capabilities

IF YOU THINK YOU CAN'T SEAL IT, YOU HAVEN'T TRIED PNEUMA-SEAL®

Pneuma-Seal® is an inflatable gasket that is pressurized with air. It fills the gaps between surfaces, even hard-to-seal uneven surfaces. When deflated, Pneuma-Seal quickly retracts preventing interference when opening and closing a door or cover.

Use Pneuma-Seal as an effective barrier against pressure differentials and to seal out water, dust, gas, chemicals, noise and other contaminants.

Typical applications include:

Processing equipment: chemical, food, textile, pharmaceuticals, dryers, ovens and where **rapid sealing and unsealing** are required.

Pollution control: sound attenuation, hopper seals.

Laboratory facilities: test equipment, clean rooms.

Transportation: military vehicles, aircraft, shipboard, mass transit doors and hatches.

Construction: special purpose doors, flood protection.

Pneuma-Seal is particularly suitable for:

Large enclosures where it is uneconomical to machine the entire sealing surface.

Uneven fabrications where traditional compression gaskets or latches are ineffective.

Horizontal or vertical sliding doors or covers that would tend to drag on and abrade conventional seals.

Hinged doors where flush thresholds are required.

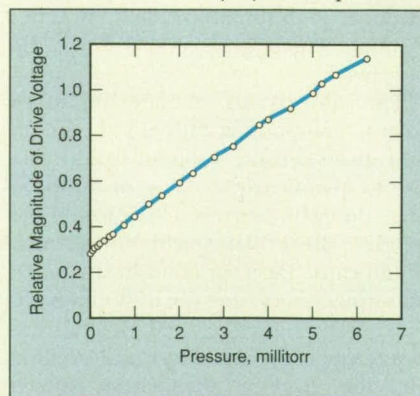
To obtain our complimentary designer's handbook, engineering assistance or to have a Presray representative contact you, please call, fax, E-mail or reach us on the Worldwide Web:

(845) 855-1220 • FAX: (845) 855-1139
West Coast: (949) 475-9842 • Fax: (949) 475-9859

E-mail: info@presray.com
<http://www.presray.com>

PRESRAY

Presray Corporation
159 Charles Colman Boulevard
Pawling, NY 12564-1193



Nearly Linear Response was observed at pressures less than about 6 millitorr (0.8 Pa).

of the drive circuit; it should be possible to design the circuit to achieve a resolution of $< 10^{-6}$ torr ($< 10^{-4}$ Pa) over the extended pressure range.

This work was done by Roman C. Gutierrez, Tony K. Tang, Jaroslava Wilcox, William J. Kaiser, Christopher B. Stell, Vatche Vorperian, and Kirill V. Shcheglov of Caltech for NASA's Jet Propulsion Laboratory. For further information, access the Technical Support Package (TSP) free on-line at www.nasatech.com under the Mechanics category.

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, NASA Management Office-JPL; (818) 354-4770. Refer to NPO-20052.

Integrated Capacitive Wheel-Contact Sensors

Features include low power, light weight, and simplicity.

NASA's Jet Propulsion Laboratory, Pasadena, California

A low-power capacitive proximity sensor has been developed as a prototype of wheel-contact sensors for a small robotic vehicle. The sensor is integrated into a wheel and consists of only a few components that add very little mass to the wheel. The output of the sensor serves as an indication of contact with (or proximity of) the ground; this output can be used as feedback for a vehicle control system. An important aspect of the circuit design is the use of capacitive (instead of slip-ring) coupling between the sensor circuit and associated external circuitry; in comparison with a slip ring, a capacitive coupler is more reliable, less electrically noisy, lighter in weight, and less mechanically complex.

The figure schematically depicts the sensor and the associated external circuitry. An application-specific integrated circuit (ASIC) generates a 1/2-duty-cycle square wave with a repetition frequency of 12.5 MHz. The square-wave signal is low-pass filtered to obtain a 12.5-MHz pseudo-sine wave for excitation of the sensor.

The sensor includes an inner aluminum foil ring covered by a layer of quartz glass fibers, covered in turn by an outer aluminum foil ring, over which are wrapped a ring of polyimide sheet and



IMAGINE

VirtualGIS™

(Your Solution.)

Take your next project to a new, three-dimensional level. IMAGINE VirtualGIS™ gives you a powerful, 3D visual analysis tool that supports dynamic visualization, flight sequences, and the management/assimilation of multiple geographic data types in a real-time, 3D environment. With IMAGINE VirtualGIS, you can create interactive 3D models as well as 3D Web content, and print high-resolution 3D images. And, because ERDAS is committed to building long-term relationships with its clients, technical support, training, custom applications development, and project consulting services are all available to make sure your project is a success. ERDAS has your solution. Call today or visit www.erdas.com/vgis.



ERDAS Worldwide Headquarters
Toll Free: +1 877-GO ERDAS (463-7327)
Phone: +1 404-248-9000
Fax: +1 404-248-9400
Email: info@erdas.com

ERDAS in Europe, Africa, Middle East
Phone: +44 1223-881774
Fax: +44 1223-880160
Email: eame@erdas.com

All Other Worldwide Inquiries
Phone: +1 404-248-9000
Fax: +1 404-248-9400
Email: info@erdas.com

Copyright © 2001 ERDAS, Inc. All rights reserved. ERDAS is a registered trademark. IMAGINE VirtualGIS is a trademark. Geographic Imaging Made Simple is a service mark of ERDAS, Inc. Imagery courtesy of GIMS. cc 5/01

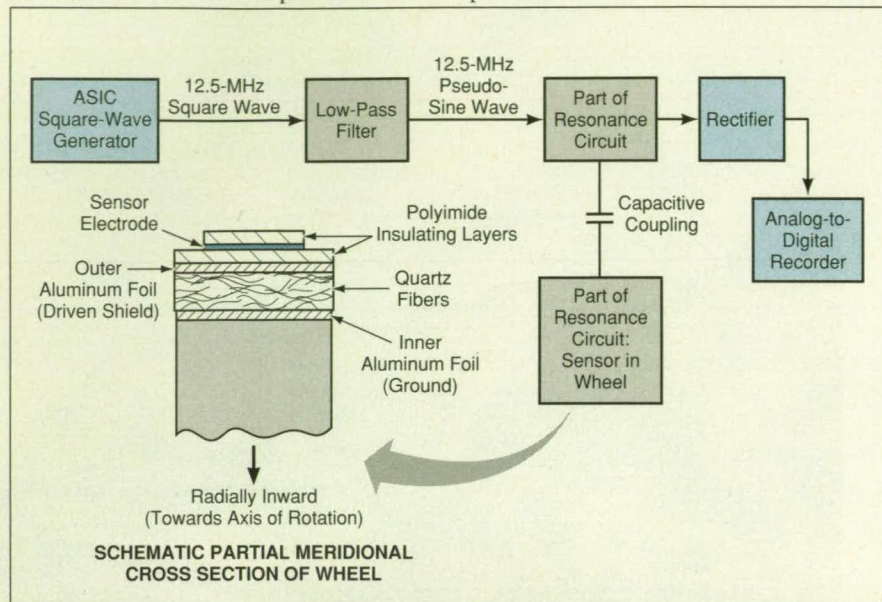
then a narrower ring of metallized polyimide sheet. The innermost aluminum foil ring acts as electrical ground. The outer aluminum foil ring acts as a driven shield, which is excited in phase with the

sensor electrode described next. The metal layer on the metallized polyimide sheet serves as the capacitive sensor electrode, which is part of an inductor/capacitor/resistor circuit that resonates at

a frequency of 11 MHz in the absence of nearby objects.

Proximity of the ground or an obstacle manifests itself through the effect of the ground or obstacle material on the capacitance of the sensor electrode. Typically, contact with the ground or an obstacle causes the capacitance to change by an amount between 0.3 and 1.3 pF. The change in capacitance causes a change in the resonance frequency and thus a change in signal amplitude along the slope of a voltage-vs.-frequency resonance curve at a suitable measurement point in the sensor circuit. The voltage is sampled at the measurement point and converted to a dc output voltage, which is then digitized for further processing by the vehicle control system.

This work was done by R. Scott Cozy, Brian Wilcox, and Mike Newell of Caltech and John Vranish of Goddard Space Flight Center for NASA's Jet Propulsion Laboratory. For further information, access the Technical Support Package (TSP) free on-line at www.nasatech.com under the Electronic Components and Systems category. NPO-20787



A Capacitive Proximity Sensor is built into a wheel and is capacitively coupled to associated external circuitry.

Rare-Earth Optical Temperature Sensors

These sensors exploit the narrow-band emission peculiar to rare earths.

John H. Glenn Research Center, Cleveland, Ohio

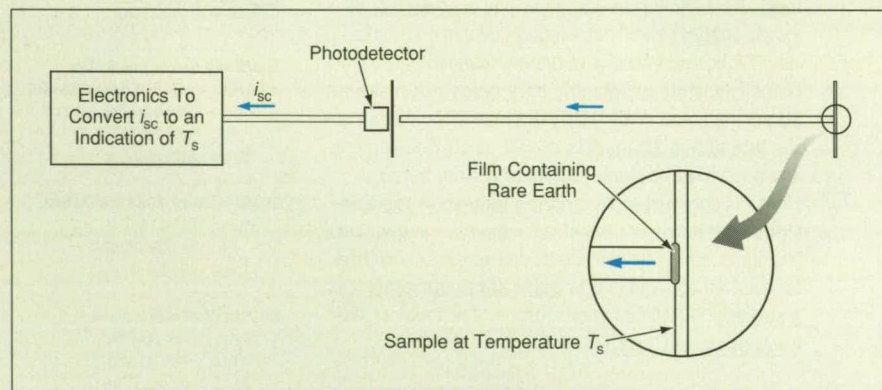
A recently developed type of fiber-optic temperature sensor utilizes narrow-band near-infrared radiation emitted by rare-earth ions. These sensors are suitable for use in harsh environments at temperatures above the maximum (1,700 °C) that Pt/Rh thermocouples can withstand. The maximum operating temperature for these optical temperature sensors can equal or exceed 2,000 °C, the exact values depending on the choice of fiber-optic

and rare-earth-containing radiative materials. The minimum temperature measurable by use of a sensor of this type, related to the minimum detectable radiation, has been found to be ≈ 700 K (≈ 427 °C).

Most atoms and molecules at solid-state densities emit electromagnetic radiation in continuous spectra much like those of black bodies. However, even at solid-state densities, the rare earths emit radiation in narrow bands much

like those of isolated atoms — a consequence of the electron wave functions peculiar to the rare earths. The development of the present rare-earth optical temperature sensors is a result of prior research on rare-earth-containing selective emitters for thermophotovoltaic energy conversion. In that research, it was found that rare-earth-doped yttrium aluminum garnet ($\text{Re}_x\text{Y}_{3-x}\text{Al}_5\text{O}_{12}$, where Re = signifies Yb, Er, Tm, or Ho) is an excellent selective emitter. It is chemically stable at high temperatures ($>1,500$ °C) and is characterized by emittances of ≈ 0.7 in the near-infrared wavelength range of interest for measuring temperatures.

A sensor of this type (see figure) is an optical fiber, coated at its input (hot) end with a film that contains a rare earth. The rare-earth-containing tip of the fiber is placed in contact with the object, the temperature of which is to be determined. Infrared radiation emitted at the input end of the optical fiber travels to the output end of the fiber, then through a band-pass filter with a narrow pass band that lies within the emission



Narrow-Band Infrared Light emitted by rare-earth ions in a film in contact with a hot sample is measured to obtain an indication of the temperature of the sample.



Still puzzled about how to cut or mark your product?

Steel, labels, acrylic, foam, cork, leather, fabric, lace, gaskets, sail cloth, nylon, sandpaper, vinyl, specialty paper, wood, and plastic. Every day over 30,000 Synrad CO₂ lasers cut, drill and mark these and many other materials. Applications are practically boundless - the more you learn about our lasers, the more uses you will find for them.

Simple to use with the reliability demanded by the toughest industrial applications. No gas bottles to replace, tools to sharpen or nozzles to clean - our lasers offer maintenance-free operation 24 hours a day for over four years. That's why Synrad lasers cost less to buy and run than other technologies.

Integrating our lasers into your existing application is easy. We design our CO₂ lasers to be components - think of them as light bulbs - to mate with XY tables, gantry systems, or robot arms. No major redesigns are necessary to obtain the benefits of laser processing.

Our all-sealed technology means no adjustments or alignment problems - ever.

Eliminate die cutters, blades, scribes or ink. The small focused laser beam produces sharp, clean edges and, as the process is non-contact, intricate patterns can be cut in thin, delicate materials with no drag - even at high speeds. CO₂ lasers can offer increased precision, higher processing speeds and less waste.

Never used a laser before? Neither had most of our customers before talking to us. To learn how sealed CO₂ lasers can help improve your process quality and reduce your manufacturing time and costs, call 1.800.SYNRAD1 today.

www.synrad.com



Send us your samples for a **FREE Process Evaluation**

Can you benefit from laser technology? Find out by sending us samples (remember to include a description of your current process and, if possible, an example of a "finished" product). You'll receive a Synrad SamplePak containing your samples (suitably marked, drilled or cut by our Applications Facility), a written Materials Evaluation and more information on implementing laser technology.



wavelength band of the rare earth. The filtered radiation impinges on a photodetector, the output of which is processed to obtain an indication of temperature.

Assuming that the photodetector is a photovoltaic device that is operated in a short-circuit configuration, it has been shown theoretically that the absolute temperature, T_s , of the hot sensor tip should be given by

$$T_s = [T_c^{-1} + (\lambda_f k / hc_0) \ln(i_c / i_{sc})]^{-1}$$

where T_c is a known calibration temperature, λ_f is the middle wavelength of the filter pass band, k is Boltzmann's constant, h is Planck's constant, c_0 is the speed of light in a vacuum, i_c is the short-

circuit detector current measured when the sensor tip is at the calibration temperature, and i_{sc} is the short-circuit detector current measured when the sensor tip is at the temperature, T_s , that one seeks to determine.

A prototype sensor was constructed with a sapphire optical fiber tipped by an $\text{Er}_3\text{Al}_5\text{O}_{12}$ emitter, a chopper, a filter of $\lambda_f = 1,012$ nm, a silicon photodetector, and a lock-in amplifier for measuring the short-circuit detector current. The prototype sensor was calibrated at a temperature of 1,879 K. Then temperatures calculated from i_{sc} readings by use of the equation given above were compared with simultaneous thermocouple measurements. The re-

sults of these measurements showed the worst-case fractional temperature error to be only 0.03, thereby confirming the validity of the equation and the underlying temperature-measurement principle.

This work was done by Donald L. Chubb and David S. Wolford of Glenn Research Center. For further information, access the Technical Support Package (TSP) free on-line at www.nasatech.com under the Physical Sciences category.

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Commercial Technology Office, Attn: Steve Fedor, Mail Stop 4-8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-17138.

Microelectromechanical Sensors Based on Magnetoresistance

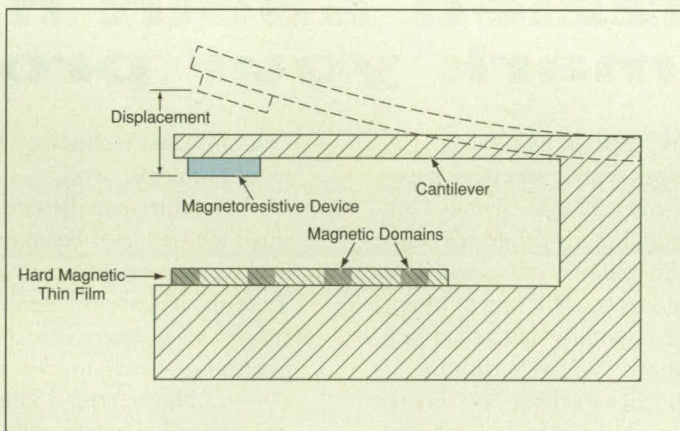
These would offer advantages over similar sensors based on quantum-mechanical tunneling of electrons.

NASA's Jet Propulsion Laboratory, Pasadena, California

Microelectromechanical sensors based on magnetoresistance have been proposed. Like other microelectromechanical sensors, these would be used to measure physical quantities that can be made to manifest themselves in small mechanical displacements. Potential applications for microelectromechanical sensors include accelerometers, magnetometers, bolometers, pressure sensors, seismometers, Golay cells, and microphones. Potential markets include the aerospace, biomedical, semiconductor, automotive, and defense industries.

Similar microelectromechanical sensors based on quantum-mechanical tunneling of electrons at movable tips of diaphragms, cantilevers, and other flexible members have been developed, and have been reported in a number of previous articles in *NASA Tech Briefs*. The fabrication and electrical characterization of the tunneling-based sensors have proven to be difficult. Operation has proven to be difficult in that tunneling tips must be kept spaced about 1 nm apart; tips often crash together, with consequent damage, leading to rejection of parts.

The proposed sensors are expected to be less problematic, because they would be manufactured and operated by use of techniques that have become well estab-



The Magnetoresistive Device would be used to measure the local strength of the magnetic field of the film. Because the magnetic-field strength would depend on the distance from the film, the measurement would indicate the displacement of the cantilever from the equilibrium position.

lished in the data-storage (computer-disk) industry. In a typical sensor of proposed type, a magnetoresistive device mounted on a diaphragm or near the free end of a cantilever in a magnetic-field gradient (see figure) would be used to measure the field strength and thus, indirectly, the distance from the source of the magnetic field. This distance would, in turn, be indicative of the displacement of the diaphragm or cantilever from an equilibrium distance. The magnetic field would be provided by a hard magnetic thin film attached to the relatively stationary portion of the device structure, facing the magnetoresistive device. The strength and gradient of the magnetic field would depend partly on

the thickness of the film and partly on the distances between magnetic domains in the film.

Unlike in a tunneling-based sensor, it would not be necessary to maintain a distance of about 1 nm or less between tunneling tips; instead, the film thickness and thus the magnetic-field strength could be increased to enable the use of a greater equilibrium distance between the magnetoresistive device and the film, making the proposed sensor less vulnerable to damage. Also, inasmuch as techniques for measuring

magnetic fields are well established in the data-recording industry, magnetic-field changes corresponding to subnanometer displacements could be measured accurately.

This work was done by John D. Olivas and Bruce Lairson of Caltech for NASA's Jet Propulsion Laboratory. For further information, access the Technical Support Package (TSP) free on-line at www.nasatech.com under the Physical Sciences category.

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, NASA Management Office-JPL; (818) 354-4770. Refer to NPO-20146.

Capacitive Sensor for Measuring Level of Liquid Nitrogen

The liquid is used as a dielectric layer in a parallel-plate capacitor.

Lyndon B. Johnson Space Center, Houston, Texas

The feasibility of a capacitive sensor for measuring the level of liquid nitrogen in a container has been demonstrated. The basic sensor design could also readily be adapted to measurement of the levels of cryogenic liquids other than nitrogen.

The general concept of capacitive sensors is not new. The novel aspect of this particular capacitive sensor lies in the use of the liquid nitrogen as part of the dielectric of a capacitor. Two vertically parallel, electrically conductive plates constitute the electrodes of the capacitor and are partly immersed in the liquid from the top, so that the top surface of the liquid lies somewhere along the plates. As the level of the liquid varies, the amount of dielectric material between the plates, and thus the capacitance, also varies. It is possible to compute the level of the liquid from (1) a measurement of the capacitance or a quantity related to capacitance in a known way and (2) the known relationship between the liquid level and the capacitance.

Several other types of sensors for measuring the levels of cryogenic liquids are available. The transducers in those sensors include, variously, cryodiodes, carbon resistors, hot-wire sensors, and simple floats. Each type is disadvantageous in one or more ways:

- Cryodiodes are expensive (costing about \$500 apiece), and the electrical currents through them must be conditioned in order to enable detection of liquid/vapor interfaces for proper measurement of liquid levels.
- Because carbon resistors are insensitive to liquid/vapor interfaces, they give only rough indications of the levels of cryogenic liquids.
- Hot-wire sensors can give inaccurate readings when liquids boil next to the wires.
- Simple floats provide good visual indications of liquid levels, but their outputs cannot be fed directly to computer data-acquisition systems.

The first step in the development of the present capacitive sensor was to establish the relative permittivity of liquid nitrogen (≈ 1.454), gaseous nitrogen (1.0005480), and air (1.0005364) at the boiling temperature of liquid nitrogen at standard atmospheric pressure. The electrodes of a prototype of this sensor were made from two copper-clad circuit boards with a thickness of 0.010 in. (0.254 mm), a length of 10 in. (25.4 cm), and a width of 1 in. (2.54 cm). The boards were

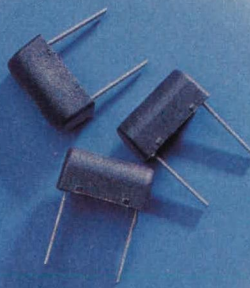
secured with five nylon screws, nuts, and washers spaced 0.070 in. (1.78 mm) apart. A wire was soldered to the top of each plate, and the wires were attached in parallel to another capacitor that constituted part of the time base of a free-running oscillator. The plate structure was placed inside a Dewar flask, into which liquid nitrogen was poured. As the liquid level increased, the capacitance of the

plate structure likewise increased. In subsequent demonstrations, this prototype sensor performed consistently, and thus its capability was proved conclusively.

This work was done by Tim E. Roth of AlliedSignal, Inc., for Johnson Space Center. For further information, contact the Johnson Space Center Commercial Technology Office at (281) 483-0474. MSC-22792

Heart Monitors • Bicycle Computers • Airbag Triggers • Security Sensors • Door Alarms • Odometers

Don't Waste Your Motion.



Energy Generation the Wiegand Way.

You may know Wiegand Effect sensors for their use as efficient, reliable rotational pulse counters. But have you ever considered them for energy generation?

Fact is, the same mechanical motion that enables the sensor function can be redirected to produce enough energy to power a host of low-power electronic circuit applications.

Ready to power up?
We have the technology. From design and development to manufacturing and assembly, we can help you find the perfect solution for your energy generation application. Call or visit our website today.



800.243.2563 www.HIDCorp.com

Heart Monitors • Bicycle Computers • Airbag Triggers • Security Sensors • Door Alarms • Odometers

Black Jack GPS Receiver

NASA's Jet Propulsion Laboratory, Pasadena, California

The Black Jack (BJ) receiver is the revolutionary flight Global Positioning System (GPS) receiver developed by NASA to fill future needs for orbit-based GPS science. These range from a receiver to determine precise (1-cm radial accuracy goal for JASON-1) orbits, to missions using the GPS signals for remote sensing of the Earth's atmosphere. The BJ receiver follows the TurboRogue space receiver, which was successfully used in collaboration with engineers and scientists at JPL on five satellite missions. While the TurboRogue was initially designed as a high-accuracy ground receiver, the BJ was designed from the start as an instrument for use from orbit. The BJ contains many innovations to better suit it to this application. In order to simplify the analog electronics, it directly samples the amplified and filtered RF (radio-frequency) signal. This sampling produces two sample streams in quadrature for improved SNR (signal-to-noise ratio). The BJ

semicustom Application Specific Integrated Circuit (ASIC) uses a full matrix switch so that inputs from multiple antennas can be directed to any of 48 tracking channels. Other ASIC capabilities are telemetry reception, tone tracking, and precise time tagging of external events. Although the receiver is designed as a science instrument rather than for mission-critical operation, it does contain innovative features such as the capability to operate in a bit-grab mode. In the event the highly-redundant digital processing fails, the main processor stops, or the spacecraft can no longer power the GPS receiver, the BJ can turn on for less than a second every hour, and still transmit data to the ground allowing sub-100-m orbit determination. The BJ receiver is designed with excess processor capacity to allow it to perform non-GPS functions; for example, on the GRACE mission, the BJ controls an intersatellite K-band link and also processes the

output of a star camera to determine spacecraft attitude.

This work was done by Thomas Meehan, Jeffrey Srinivasan, Jeffrey Tien, Garth Franklin, Donovan Spitzmesser, Timothy Munson, and Charles Dunn of Caltech for NASA's Jet Propulsion Laboratory. To obtain a copy of the report, "Black Jack GPS Receiver," access the Technical Support Package (TSP) free on-line at www.nasatech.com under the Electronic Components and Systems category.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to

*Technology Reporting Office
JPL*

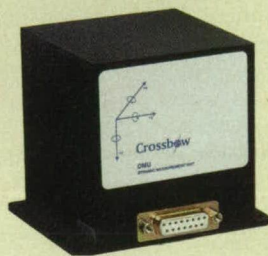
*Mail Stop 249-103
4800 Oak Grove Drive
Pasadena, CA 91109
(818) 354-2240*

Refer to NPO-20891, volume and number of this NASA Tech Briefs issue, and the page number.

STAY
ON | TARGET...



...with Crossbow
High Performance Sensors



- UAV control
- Avionics
- Payload stabilization
- UUV/ROV navigation
- Dynamic testing

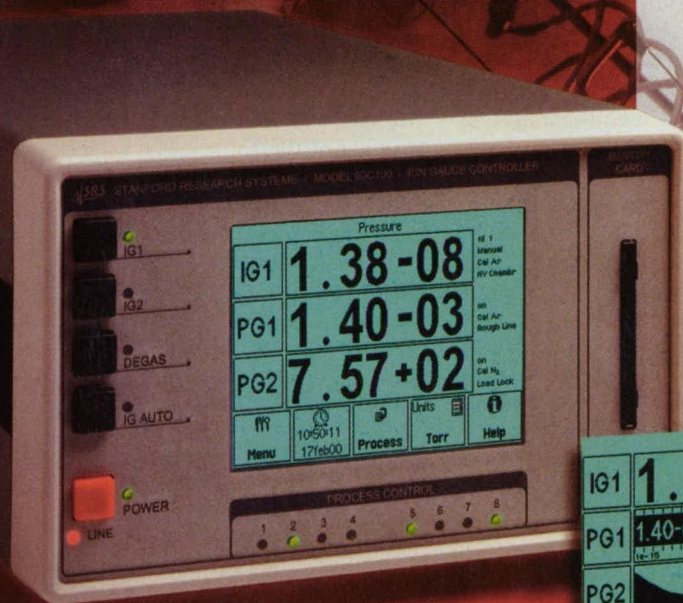
When looking for high-quality solid-state IMUs, AHRS or Vertical Gyros, Crossbow Technology has the ideal product for your air, land, and marine applications. The DMU® family of MEMS- and FOG-based inertial systems provides a low-cost, high-performance solution for control, navigation, stabilization and instrumentation.

Stay on Target
Contact Us Today

408.965.3300 • fax 408.324.4840 • info@xbow.com
www.xbow.com

Demand more from your Ion Gauge Controller

- 1000 Torr to UHV range
- 0.3% controller accuracy
- Bayard-Alpert gauge compatible
- Pressure vs. time curves
- 4 analog input/output ports
- RS-232 interface
- 8 process control channels (opt)
- GPIB and Web interfaces (opt)

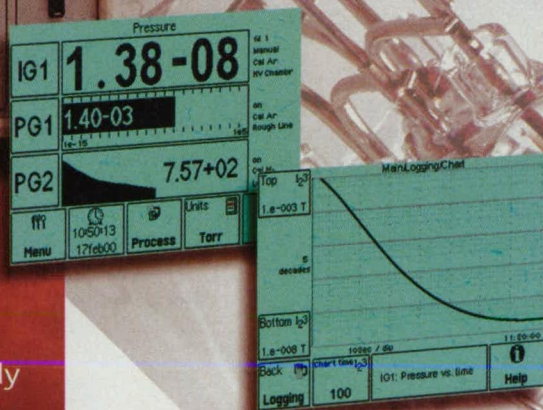


\$1495 (U.S. list)

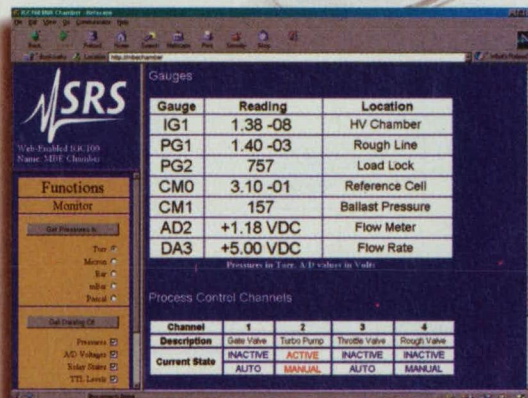
The IGC100 is much more than a conventional ion gauge controller. Not only does it monitor pressure from up to two ionization gauges, two convection enhanced Pirani gauges and four capacitance manometers, but it also has many useful features that have never been available before in a controller.

We've added a touchscreen display that can show pressure vs. time curves so you can closely monitor the behavior of your chamber. Also included are eight process control channels and four analog I/O ports for automated system control.

The IGC100 is accurate to 0.3% and we offer NIST traceable gauge calibration at a very reasonable price.



Best of all, the IGC100 is fully web-ready! All you need is a computer, your favorite browser and a network connection, and you can access your controller from anywhere in the world.



Stanford Research Systems

Phone: (408) 744-9040 • Fax: (408) 744-9049 • email: info@thinkSRS.com • www.thinkSRS.com



Digitally Programmable Analog Membership-Function Circuits

These circuits exploit the best features of analog and digital implementations.

NASA's Jet Propulsion Laboratory, Pasadena, California

Digitally programmable analog membership-function circuits have been invented for use in fuzzy-logic systems. Heretofore, fuzzy membership functions have been implemented, variously, by use of purely analog or purely digital circuits. Purely digital circuits afford flexibility at the cost of less speed and greater circuit area. Purely analog circuits offer greater speed and occupy less area but tend to be limited in flexibility and programmability. The present invention takes advantage of both the programmability of digital circuitry and the speed and compactness of analog circuitry. The analog aspect of the invention creates the potential for high-speed parallel processing with relatively low power consumption.

In designing a circuit according to the invention, one uses current-mode circuitry to implement fuzzification in a fully parallel architecture while using

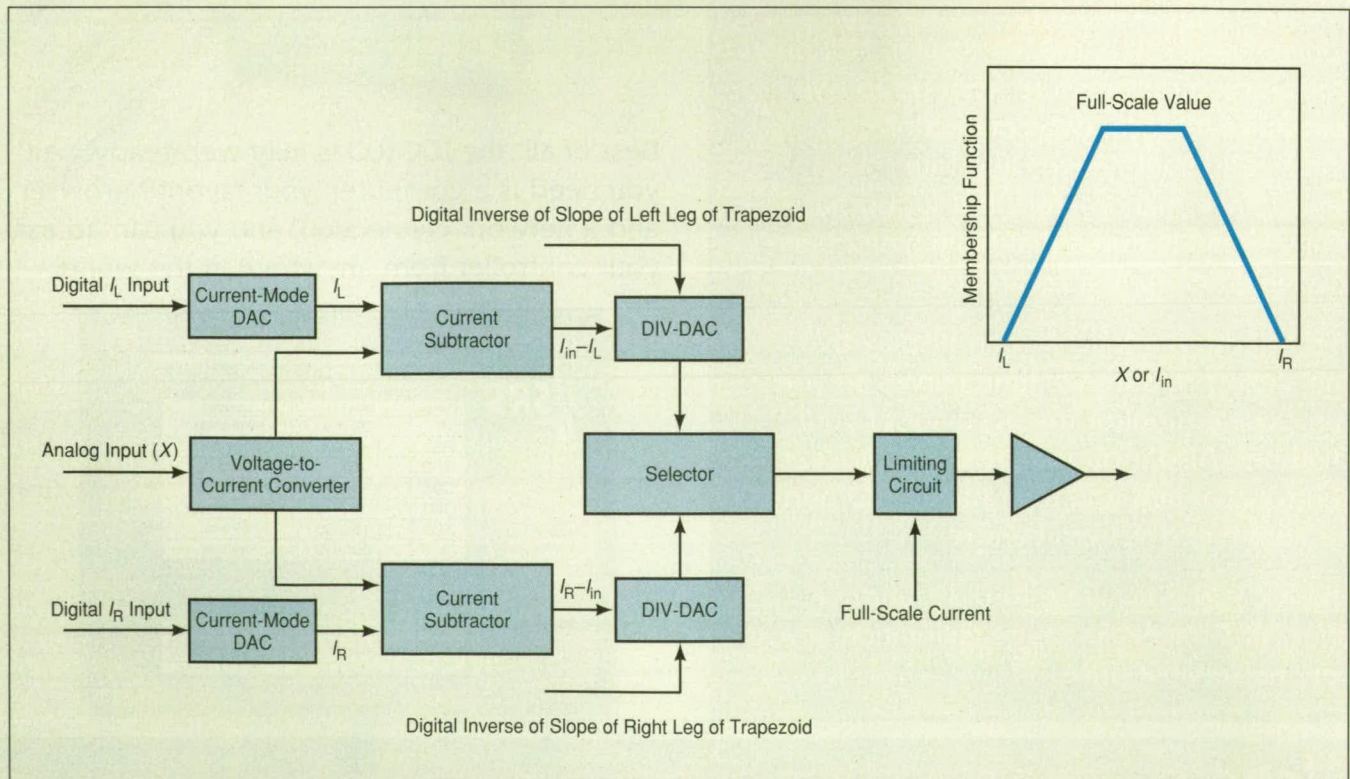
a digital interface for programmability of attributes of membership functions. In a typical case, a membership-function circuit accepts an analog input potential and implements a trapezoidal membership function (see figure). First, the input potential signal (X) is converted to a current-mode signal (I_{in}) for further processing. Two current-mode digital-to-analog converters (DACs) provide currents I_L and I_R that represent zero-crossing locations of the left and right legs, respectively, of the trapezoidal membership function.

Current subtractors generate $I_{in} - I_L$ and $I_R - I_{in}$, and feed these difference currents as analog inputs to dividing digital-to-analog converters (DIV-DACs). [Alternatively, one could use multiplying digital-to-analog converters (M-DACs); the advantage of DIV-DACs is that they provide more evenly spaced increments, which makes the range of programmable slopes more

useful.] The digital input to each DIV-DAC is a number inversely proportional to the slope of the corresponding leg of the trapezoidal membership function. In each DIV-DAC, the analog difference-current input is divided by the digital inverse-slope input to obtain the ordinate on the affected leg of the trapezoid. A comparator circuit selects the output of either the left- or the right-leg DIV-DAC, and a limiting circuit clips the output at a level corresponding to the top of the trapezoid. The output current of the limiting circuit is converted to an output voltage.

This work was done by Tyson Thomas and David Weldon of Caltech for NASA's Jet Propulsion Laboratory. For further information, access the Technical Support Package (TSP) free on-line at www.nasatech.com under the Electronic Components and Systems category.

NPO-20810



A Combination of Analog and Digital Circuits implements a trapezoidal membership function of an analog input signal. The digital inputs establish the parameters of the trapezoid.

Let's see,
should you buy two
of theirs or just
one of ours?



Instead of buying separate instruments for sourcing and measuring, get it all in one compact, cost-effective unit—a Keithley Series 2400 SourceMeter®. Each one combines a programmable power source with a highly repeatable, 5½ digit DMM in one handy, integrated unit. Which means you can use it as a V-Source, I-Source, V-Meter, I-Meter—even an ohmmeter. Just set it up, and you're ready for almost any DC measurement you can think of. You can even link any SourceMeter

to popular component handlers for binning and sorting. And they're fully compatible with Keithley's highly acclaimed switching cards and systems for fast, accurate handling of multi-point test applications. Increasing throughput, yield and productivity has never been simpler. Getting all the specs is easy, too. Just download your **FREE SourceMeter Kit** at the URL below, or call us today at 1-888-534-8453. We'll be glad to answer all of your questions.

Learn more at 1.888.KEITHLEY or www.keithley.com or
request your **FREE SourceMeter Kit** at www.keithley.com/2400

KEITHLEY

A GREATER MEASURE OF CONFIDENCE

For More Information Circle No. 553

Regenerative Pseudonoise Ranging

The effective return ranging power could be increased greatly.

NASA's Jet Propulsion Laboratory, Pasadena, California

In a proposed improved technique for pseudonoise turnaround ranging of a radio transponder, the pseudonoise modulating signal would be regenerated in the transponder. The net result of the regeneration would be an increase in the effective return ranging power. This increase would provide some margin for decreasing ranging time, decreasing the

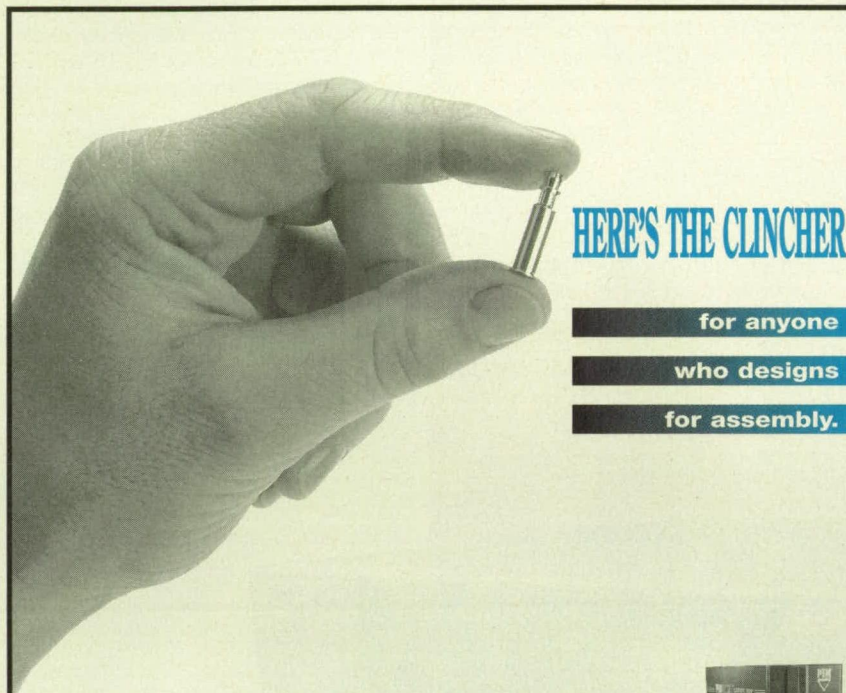
power of the return ranging signal transmitted by the transponder, or increasing the power of another (e.g., telemetric) signal transmitted from the vehicle that carries the transponder. The technique was conceived for use in measuring the distance between a master station on Earth and a spacecraft that carries a transponder; with modifications, it may

also prove useful in other applications that involve ranging and/or communications in both outer-space and terrestrial settings.

In turnaround ranging, one determines the distance between the master station and the transponder by measuring the round-trip travel time for a known ranging signal modulated onto a carrier signal (denoted the uplink carrier signal) transmitted by the master station. The receiver in the transponder locks onto the uplink carrier signal, demodulates the ranging signal, and re-modulates the ranging signal onto another carrier signal (denoted the downlink carrier signal), which is coherently related to the uplink carrier. A receiver at the master station locks to the downlink carrier signal and demodulates the ranging signal. Finally, the received ranging signal is correlated with the transmitted ranging signal, and the offset between the two signals that yields the maximum correlation amplitude constitutes the estimate of the round-trip signal travel time.

In this case, the ranging signal would be a pseudonoise binary sequence that would be phase-modulated onto the uplink carrier. Pseudonoise binary sequences have been used before in turnaround ranging of spacecraft because they offer a desirable combination of high ranging resolution, low ranging ambiguity, and no need for receivers to "know" when pseudonoise sequences started.

The need for regeneration of the pseudonoise sequence (or, for that matter, any other ranging signal) in a transponder arises as follows: In the transponder, in the absence of regeneration, uplink noise is received along with the ranging signal, so that unavoidably, the uplink noise is modulated onto the downlink carrier along with the ranging signal. In a typical deep-space application, the retransmitted uplink noise power can exceed the retransmitted ranging power by as much as 30 to 40 dB. Thus, a considerable amount of power that could otherwise be used for telemetry or other purposes is wasted retransmitting the uplink noise, and the retransmitted noise degrades the ranging signal received at the Earth or other master station. If the pseudonoise sequence could be regenerated in the transponder with proper timing instead



HERE'S THE CLINCHER

for anyone

who designs

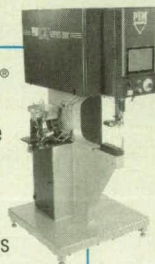
for assembly.

Less is more.

Less parts, less assembly steps, less assembly time – all yield more productivity and more cost reductions. To achieve this, designing for assembly (DFA) is critical.

PEM® products are made for DFA. Just punch or drill a hole and press a PEM fastener into place. PEM self-clinching fasteners install permanently into thin sheets. There are fewer parts and fewer total pieces to handle during assembly which translates into cost savings. We also offer threadless and multi-function fasteners to further meet your DFA needs.

These include SNAP-TOP® (shown in photo above) standoffs which eliminate the need for screws, locating pins for quick alignment of mating parts, P.C. board fasteners and many others.



For automated installation, our line of PEMserter® presses quickly install PEM fasteners, further reducing assembly time.

Clinch it with PEM®
FASTENERS & PRESSES

PEM Fastening Systems
a PennEngineering® company

©2001 210

800-237-4736 • www.pemnet.com



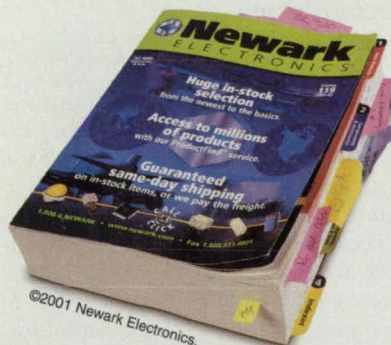


YOU NEED WE SPEED.



FAST SHIPPING. In today's world, you can't afford to wait. That's why Newark offers guaranteed same-day shipping on all in-stock items ordered on a weekday before 5 p.m. CST. Which means you can get exactly what you need, right when you need it.

For your **FREE** 2001-02 Newark catalog, call 1-800-639-2757.



Newark
ELECTRONICS®



1-800-639-2757

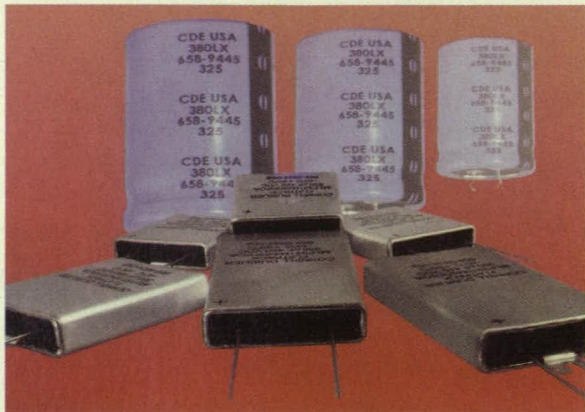


www.newark.com



CD-ROM Vol. #119

Look Out Snap-Ins: Flatpack is Back!



Twice the ripple current and 8 times the life. Now you can shrink your power supply or motor drive with a 1/2 inch flatpack handling the ripple current of two or three snap-in capacitors, and revel in your ultra compact and reliable design. For instance, our life tests show that a 500 μ F 250 V flatpack can take 3.8 Amps of ripple current for 4000 hours at 105°C. To match the ripple capability, you would need three snap-ins. And new automation has made the flatpack affordable. So go flat. Get the latest MLP and MLS Flatpack information. **Cornell Dubilier**, 140 Technology Place, Liberty, SC 29657; (864) 843-2277; Fax: (864) 843-3800, cde@cornell-dubilier.com; www.cornell-dubilier.com



For More Information Circle No. 487 or Visit www.nasatech.com/487

Heavy-Duty Sensor for harsh environments

Our PE30 inductive sensor was designed for the rigors of the off-highway market.

Its proven record for durability is great news for anyone in need of a heavy duty proximity switch.

- Limit switches
- Interlocks
- Position Indicators
on doors, buckets,
actuators, booms and
conveyors



Call or visit our website for info...

Lifetime Warranty • 30-Day Free Trial

call toll-free

1.800.315.9233

www.gordonproducts.com



GORDON
Products, Incorporated

phone: 1.203.775.4501 • fax: 1.203.775.1162

Send Literature Circle No. 430 Have Salesman Call Circle No. 431

of being simply turned around along with the uplink noise, then it could be retransmitted without the uplink noise, thereby increasing the ranging-signal-to-noise ratio.

The major task for the transponder at any given time is to determine the current position in the pseudonoise sequence in order to regenerate and retransmit the sequence with proper timing. Part of this task is to determine the current phase of the ranging signal. Assuming that the ranging signal is frequency-coherent with the uplink carrier signal, following standard practice in turnaround ranging, the proposed technique would involve locking to the received uplink carrier signal to obtain a timing signal for a numerically controlled oscillator in a pseudonoise-sequence-tracking loop (also called a "chip-tracking" loop).

Because the ranging signal would look like a square-wave signal except for an occasional flip in polarity, the phase of the signal would be tracked by use of a first-order square-wave phase-locked loop. The nature of the pseudonoise sequence would be such that the tracking phase error would average out to zero in the long term, and the effect of the tracking phase error could be diminished through low-pass filtering. Because the phase-error output of a phase-locked loop is proportional to the signal amplitude, which can vary widely, an automatic gain control (AGC) would be necessary for normalizing the amplitude before input to the loop filter. The reference amplitude signal for the AGC would be the amplitude of the signal in the in-phase channel of the carrier-tracking loop.

The chip-tracking loop would contain correlators instead of a traditional lock detector. The correlators would integrate over a desired number of pseudonoise-repetition periods (chips), and the current position relative to the pseudonoise sequence would be determined from the correlator outputs. The timing of the transmitting pseudonoise-sequence generator would be set accordingly, and the numerically controlled oscillator in the chip-tracking loop would be used to clock the binary modulation sequence to the downlink transmitter. After each integration period, the current positions in the transmitted and received pseudonoise sequences would be compared; agreement of these positions would signify lock.

This work was done by Jeff Berner, James M. Layland, Peter Kinman, and John R. Smith of Caltech for NASA's Jet Propulsion Laboratory. For further information, access the Technical Support Package (TSP) free on-line at www.nasatech.com under the Electronic Components and Systems category.

NPO-20846

Biomorphic Analog Pulse-Coupled Neural Circuits

These circuits are potentially useful for invariant pattern recognition.

NASA's Jet Propulsion Laboratory, Pasadena, California

Analog electronic circuits that operate with pulsed input and output signals are undergoing development. The pulsing behavior of these circuits is modeled after a similar behavior, called "spiking," that occurs in biological neural networks. In these circuits, the pulse times and/or the pulse-repetition rates can convey information. These circuits are intended especially for use in high-speed artificial neural networks, which, like the brains of animals that have vision, would process image data to effect invariant pattern recognition. (As used here, "invariant"

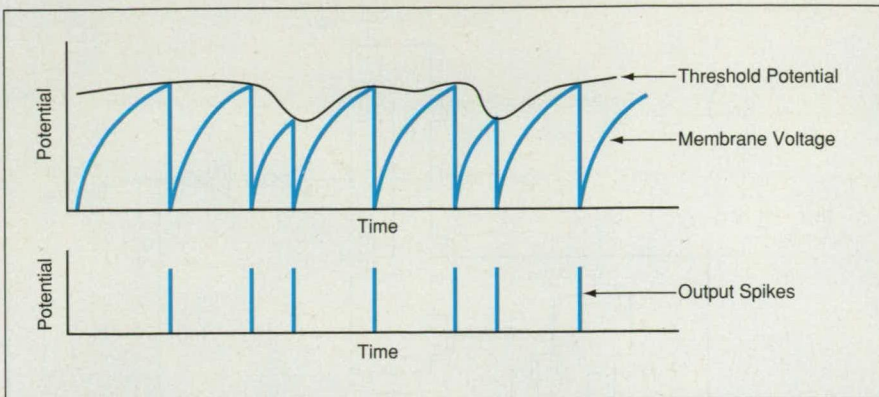


Figure 1. The Interval Between Spikes and the Buildup of Membrane Potential can be modulated by modulating the threshold potential.

signifies that the ability to recognize patterns would not be adversely affected by such effects as translation, rotation, distortion, changes in scale, or changes in brightness.)

Figure 1 depicts an example of input/output behavior according to one mathematical model of a biomorphic spiking neuron. Starting from the beginning of a pulse cycle, a membrane potential rises at rate that decays exponentially until the potential passes a time-varying threshold, at which point the neuron sends a spike along its axon. At the in-

stant of the spike, the membrane potential returns to a resting level from which the cycle starts anew. If the threshold, the resting potential, or the rate of rise of the membrane potential is modulated, then the pulse-repetition rate (also called the "spiking frequency" or the "firing rate") of the neuron is changed.

By locally connecting neurons like this one into an array in which the axons of neighbors would transmit their spike trains via synapto-dendritic connections that would modulate the thresholds, one

could construct a complex processing network. In a computational simulation, such a network has been shown to be capable of invariant mapping of binary patterns.

The invariance of the mapping is a result of encoding images in time rather than space. In particular, if the same image is fed as input to a different set of pixels but the same spatial relationships are maintained among parts of the image, the temporal representation of the image remains the same and the mapping is invariant to translation. Invariance with respect to brightness is achieved partly by recognizing that greater brightness is represented simply by a uniform increase in the average firing rates of all affected neurons.

The upper part of Figure 2 depicts a developmental spiking-neuron circuit. The clock voltage source (V_{clk}) pumps charge through a subthreshold biased transistor (M1) onto the gate capacitance of transistor M2, the gate potential of which represents the membrane potential. The current source constituted by the clock and M1 is intentionally made fairly poor (i.e., is made to have low resistance) in order to obtain a nonlinear buildup of membrane po-

Serial CompactPCI Solutions

- RS-232 or RS-422/485 interface
- 2 or 4 independent serial ports
- D-shell or modular connectors
- 2500 VRMS optical isolation
- 16750 UARTs with 64-byte FIFOs
- Windows 95/98/Me/NT/2000 and OS/2

www.quatech.com

QUATECH

800-553-1170 fax 330-434-1409 sales@quatech.com

ISO 9001 Registered Company Made in the USA

Quality ■ Reliability ■ Flexibility ■ Service

POSITIONING SLIDES AND X-Y TABLES

Modular linear and rotary slides for scanning and indexing



VELMEX, INC.

Fax: 716 657-6153

For your free Catalog M

Call: 800 642-6446
www.velmex.com/b
 or 716 657-6151 in NY

For More Information Circle No. 422

ELECTRICAL CONDUCTIVE ADHESIVES

Designed To Your Specifications

MASTER BOND EP76M EPOXY

- High conductivity
- Thermal shock resistant
- Durable, high strength bonds
- Water and chemical resistant
- Convenient packaging
- Long storage stability without refrigeration
- Repairability



Call or write:
 Master Bond Inc.
 154 Hobart Street
 Hackensack, NJ 07601
 201-343-8983

Master Bond Inc.
 Adhesives, Sealants & Coatings
www.masterbond.com

For More Information Circle No. 424

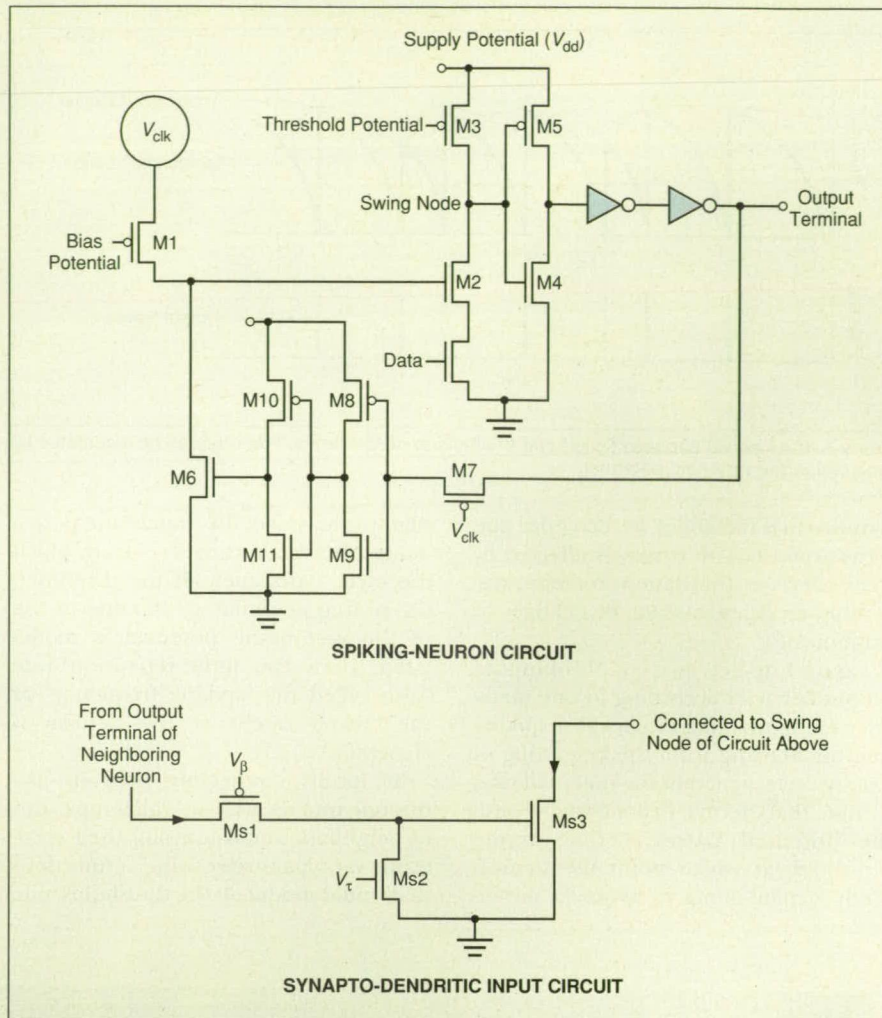


Figure 2. These Analog Neural Circuits are designed to exhibit spiking behavior that approximates that of Figure 1.

tential. When the membrane potential becomes high enough to pull M3 out of its linear current-vs.-voltage region, the voltage at the swing node rapidly decreases as M2 pulls the node toward ground. The low voltage on the swing node then triggers the inverter formed with M4 and M5 to go high, and the inverter potential is digitally buffered to the output terminal. The clocked switching transistor M7 latches the voltage output on the noncharging portion of the cycle of the current pump at M1. M8 and M9 are sized to constitute an inverter that triggers at a relatively high dc potential to insure an adequate spike amplitude before the discharge transistor M6 is activated. When M6 is switched on, all charge at the membrane is drained to ground (zero potential) or, alternatively, to a source of nonzero resting potential connected to the source terminal of M6. When the membrane potential falls, M2 shuts down and the swing node is pulled high again as M3 returns to its linear region. This change in the swing node returns the output to low, ending the

spike and switching off the discharge transistor at M6.

The lower part of Figure 2 shows a synapto-dendritic input circuit connected to the swing node of a spiking neuron. In a locally connected network, there could be eight input circuits like this one for coupling the outputs from eight nearest-neighbor neurons as inputs to the affected neuron. Transistor Ms1 sets the gain of the coupling, while transistor Ms2 controls the timing. Essentially, the spike from a neighboring neuron injects charge onto the gate of Ms3 through Ms1. This charge then slowly leaks away via Ms2 to produce a decaying exponential current response through Ms3. This current modulates the threshold of the spiking neuron by pulling M3 closer to saturation, thereby enabling a decreased membrane potential to trigger a spike.

This work was done by Tyson Thomas of Caltech for NASA's Jet Propulsion Laboratory. For further information, access the Technical Support Package (TSP) free on-line at www.nasatech.com under the Electronic Components and Systems category. NPO-20818

Weighing Scales Based on Low-Power Strain-Gauge Circuits

Small solar batteries would provide the necessary power.

NASA's Jet Propulsion Laboratory, Pasadena, California

Weighing scales (e.g., kitchen and bathroom scales) of a proposed type would incorporate sensory devices like the one described in "Low-Power, Microprocessor-Controlled Strain-Gauge Circuit" (NPO-19750), *NASA Tech Briefs*, Vol. 21, No. 1 (January 1997), page 45. Unlike other weighing scales based on strain gauges, these would not require electrochemical batteries or external power supplies; instead, the proposed scales could be powered adequately by solar batteries like those included on some pocket electronic calculators.

In a weighing scale of the proposed type, power consumption much lower than that of conventional strain-gauge circuits would be achieved by a unique combination of novel and conventional features. As explained in more detail in the earlier article, the intermittency of the operation of the microprocessor-controlled strain-gauge circuit would contribute a major portion of the reduction in time-averaged power. A further

reduction would be effected by use of a strain gauge of unusually high electrical resistance — about 3 k Ω instead of the customary value of about 120 Ω . Ordinarily, the use of the lower resistance would be dictated by the need to minimize noise pickup on strain-gauge-output wires, where the noise voltage can be comparable to the strain-gauge output voltage. In this case, however, the strain-gauge circuit would be very small and one could mount the rest of the strain-gauge circuit very close to the strain gauge; this would make it possible to shorten the electrical connections and thereby reduce noise pickup, enabling the use of the higher gauge resistance without incurring excessive noise.

A preliminary estimate shows that with a 3-k Ω strain gauge and associated circuitry operating at a supply potential of 3 V at a sampling rate of twice per second with sampling periods 100 μ s long, the overall time-averaged power consumption would be about 12 μ W. A

typical calculator-type solar battery supplies a current of about 10 μ A at a potential of 3 V (power of about 30 μ W) under full illumination. Thus, one such battery would provide at least 50 percent power margin to allow for reduced illumination.

As explained in the earlier article, the strain-gauge circuit would automatically correct for variations in the supply voltage. The microprocessor in the strain-gauge circuit could also be programmed to correct for nonlinearity in the strain-gauge response, and to provide a digitally controlled analog offset to correct for tare weight.

This work was done by Shannon P. Jackson and Harold Kirkham of Caltech for NASA's Jet Propulsion Laboratory. For further information, access the Technical Support Package (TSP) free on-line at www.nasatech.com under the Electronic Components and Systems category. NPO-19777

Lake Shore Temperature Sensors

We have the
solution to fit
your needs

LakeShore®

Lake Shore temperature sensors meet these requirements:

- Magnetic Fields
- Standard Curve
- High Sensitivity
- UltraLow Temp
- Fast Thermal Response
- High Stability
- Radiation Hard
- Wide Range

See our complete line of temperature sensors and related products at our website:

www.lakeshore.com

Lake Shore Cryotronics, Inc.
575 McCorkle Blvd.
Westerville OH 43082-8888 USA
e-mail: sales@lakeshore.com
1-800-394-2243

Generating Maps of the Ionosphere From GPS Measurements

The Global Ionospheric Monitoring and Forecasting System (GIMSYS) computer program generates global maps of the total electron content (TEC) (electron density integrated over all altitude) of the ionosphere, maps of ionospheric irregularities, and related data byproducts. The maps are generated primarily from signal-propagation measurements taken by more than 100 continuously operating two-frequency Global Positioning System (GPS) receivers in a world-wide network. GIMSYS interpolates the measurements temporally and spatially generating a global TEC map every 15 minutes. When updating the map with new measurements, GIMSYS uses a Kalman filter and stochastic estimation to obtain an optimal combination of the measurements with constraints derived from ionospheric physics and empirical ionospheric models. By applying time-series analysis to recent TEC maps, GIMSYS can also generate forecast TEC maps that are reasonably accurate for 2 to 4 hours. The numerous actual and potential users of the data products of GIMSYS include military, industrial, and academic organizations concerned with radio communication, navigation, mapping, scientific observations, and effects of ionospheric storms on power-distribution systems.

This program was written by Ulf J. Lindqwister; Charles D. Edwards, Jr.; Ron Muellerschoen; Xiaoping Pi; Anthony J. Mannucci; Lawrence Sparks; Thomas Runge; Byron A. Iijima; Mark Reyes; and Brian Wilson of Caltech for NASA's Jet Propulsion Laboratory. For further information, access the Technical Support Package (TSP) free on-line at www.nasatech.com under the Software category.

This software is available for commercial licensing. Please contact Don Hart of the California Institute of Technology at (818) 393-3425. Refer to NPO-20460.

Program for Simulating Rotor Dynamics on Personal Computers

ARDS (Analysis of RotorDynamic Systems) is a public-domain computer program that simulates transient and steady-state dynamics of a rotary machine that can include as many as five interconnected flexible shafts. ARDS can be used

to analyze the dynamics of such diverse machines as turbocompressors, turbo-pumps, gas turbines, steam turbines coupled with electric generators, power-transmission shafts, and other rotating machinery in which the flexibility of shafts is significant. Researchers at Arizona State University wrote the original version of ARDS in the FORTRAN 77 language during the early 1980s for execution on a mainframe computer. Retaining the original FORTRAN 77 language and capabilities, the code was modified into the present version, denoted ARDS-PC, for execution on personal computers. ARDS-PC is also readily convertible to a FORTRAN 90 version for personal computers.

ARDS utilizes finite-element analysis and component-mode synthesis to quickly and accurately calculate transient and steady-state rotor responses. The program includes a fourth-order Runge-Kutta integrator that uses a fixed time step specified by the user. ARDS can compute transient responses to four types of excitation: turns of entire machines about axes other than shaft axes (these turns affect rotor behavior through gyroscopic effects), variable base acceleration, variable applied forces, and suddenly applied imbalance (e.g., loss of a blade). The effects of squeeze-film dampers and dropping onto (and thus rubbing against) backup bearings and the finite stiffness of bearings (including magnetic bearings) can be included in simulations. The customary steady-state responses, including natural frequencies, critical speeds, and effect of rotor imbalance can all be calculated.

Additional functions in ARDS-PC include (1) estimating the peak response following loss of a blade without resorting to a full transient analysis; (2) calculation of sensitivity of response to input parameters; (3) formulation of optimum rotor and damper designs that are optimized in the sense that critical speeds are placed in desirable ranges or bearing loads are minimized; and (4) generation of Poincaré plots so the presence of chaotic motion can be ascertained.

ARDS-PC produces printed and plotted output. The executable code uses the full array sizes of the mainframe version and fits on a high-density floppy disc. ARDS-PC can be executed on personal computers equipped with '486 (or more capable) processors that utilize the DOS operating system with an extended memory manager.

This program was written by David P. Fleming of Glenn Research Center. For further information, access the Technical Support Package (TSP) free on-line at www.nasatech.com under the Software category.

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Commercial Technology Office, Attn: Steve Fedor, Mail Stop 4-8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-17007.

Software for Monitoring and Controlling DSN Operations

Network Monitor and Control (NMC) Automation Assembly (AA) is a component of the NMC software system, which is used for controlling an antenna connection in the Deep Space Network. NMC AA could also be adapted to commercial applications (e.g., chemical processing), in which human operators must monitor and control multiple equipment subsystems simultaneously in real time. NMC AA is designed to reduce costs and increase efficiency and capacity by relieving human operators of labor-intensive and error-prone routine spacecraft-tracking activities. NMC AA includes software engines that communicate between automation scripts and DSN subsystems. The automation scripts are developed in the Automation Language for Managing Operations (ALMO), which is a programming language that includes specialized constructs for interacting with the subsystems. The contents of the scripts represent knowledge of operations gathered from DSN operators and engineers. The ALMO scripts are organized in a temporal-dependency network and managed via a graphical user interface that enables a human operator to monitor and control the automation at any time.

This program was written by Eva Bokor, Bryan Camilli, Manuel Gomez, Patrick Oguin, Paul Pechkam, Patricia Santos, and Marla Thornton of Caltech for NASA's Jet Propulsion Laboratory. For further information, access the Technical Support Package (TSP) free on-line at www.nasatech.com under the Software category.

This software is available for commercial licensing. Please contact Don Hart of the California Institute of Technology at (818) 393-3425. Refer to NPO-20516.

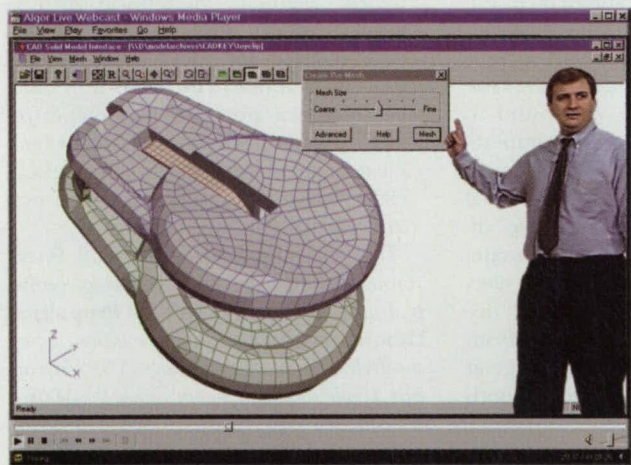
Before You Buy FEA

Watch Live Software Demonstrations on the Internet

Participate in the live software demonstration and ask your questions in real time every week

or watch past demonstrations by visiting

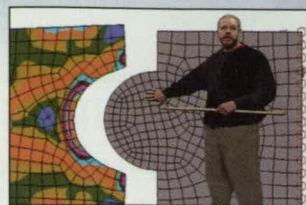
www.eTechLearning.com



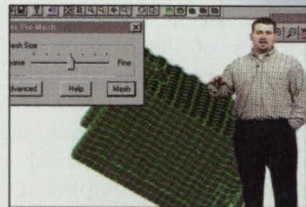
Algor's interactive software demonstrations range in topics from "What You Need to Know About FEA" to "Motion and Impact Using Algor's Mechanical Event Simulation vs. Motion Load Transfer" to illustrate how Algor software meets your engineering needs.

What You See is What You Get

The images shown here were extracted from actual webcast footage. The TV quality you see here is the same quality you will see on your desktop computer screen if you have a T1, DSL or cable modem connection, or you may request a webcast on CD-ROM.



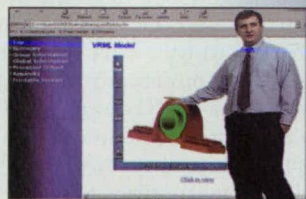
See our industry-leading Mechanical Event Simulation technology with linear or non-linear materials. In the webcast shown above, the von Mises material was used on a model which experiences impact.



Find out about FEA within CAD for solid modelers such as SolidWorks shown here.



Watch our engineers do FEA modeling in Algor, including the capability to build models like this composite wing.



See how you'll get started with Algor's FEA design, analysis and visualization capabilities with built-in HTML report support shown above.



See how you'll do linear static stress with composite elements, as in this model of a wing.

Tuesday at Ten 10:00 a.m. Eastern Time

Watch Free, One-Hour, Live Software Demonstrations Weekly on Important FEA Topics

Join Algor weekly each Tuesday at 10 a.m. Eastern Time at **www.eTechLearning.com** to learn about Algor's Finite Element Analysis and full Mechanical Event Simulation software and our InCAD products for doing FEA within CAD. Viewers can phone or e-mail questions to be answered by Algor engineers during the Webcast. Past demos are available on the same site on demand.

Schedule a Customized Software Demo to See Why Algor Software Is the Right Choice for You

Call your Algor representative today at +1 (412) 967 - 2700 to schedule your customized software demonstration at **www.eTechLearning.com**. At your convenience, Algor engineers will demonstrate on Internet TV at your computer how our Finite Element Analysis and full Mechanical Event Simulation software and InCAD products for doing FEA within CAD provide solutions to meet your engineering needs.

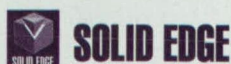
Algor, Inc.
150 Beta Drive, Pittsburgh, PA 15238-2932 USA
US Phone: +1 (412) 967-2700
Fax: +1 (412) 967-2781



When Engineering Has to be Right



Autodesk
Registered Developer



All trademarks may be trademarks or registered trademarks of their respective owners.

For More Information Circle No. 596 or Visit www.nasatech.com/596



Lithium Alkoxide Electrolyte Additives for Lithium-Ion Cells

These additives help to extend operating temperatures to as low as -40°C .

NASA's Jet Propulsion Laboratory, Pasadena, California

Alkoxides of lithium have been found to be useful as electrolyte additives to improve the low-temperature performance of rechargeable lithium-ion electrochemical cells. As explained below, an additive of this type exerts beneficial electrochemical effects both within the bulk of the electrolyte and on the surface of the carbon anode, such that the low-temperature electrical characteristics of the cell are improved.

The discovery of lithium alkoxide electrolyte additives was made during continuing research directed toward extending the range of practical operating temperatures from the present lower limit of -20°C down to -40°C , and even lower if possible. This research at earlier stages was reported in "Update on Electrolytes for Low-Temperature Lithium Cells" (NPO-20407), NASA Tech Briefs, Vol. 24, No. 1, (January, 2000), page 56. To recapitulate: the loss of performance with decreasing temperature is attributable largely to a decrease of ionic conductivity and the increase in viscosity of the electrolyte. What is needed to extend the minimum operating temperature from -20°C down to -40°C is a stable electrolyte solution with relatively small low-temperature viscosity, a large electric permittivity, adequate coordina-

tion behavior, and appropriate ranges of solubilities of liquid and salt constituents.

The electrolytes investigated intensively at earlier stages of this research were made of LiPF_6 mixed with various proportions of aliphatic carbonates. One optimal formulation that was found to yield excellent room- and low-temperature performance is a 1.0 M solution of LiPF_6 in a solvent that consists of equal volume parts of ethylene carbonate, dimethyl carbonate, and diethyl carbonate. Prototype cells that contained this electrolyte exhibited high charge and discharge capacities at temperatures from -20 to -40°C , capability for discharge at high rates, and high cycle lives at both low and room temperatures.

A lithium alkoxide additive helps to improve the low-temperature performance of a cell in the following two ways:

- A film forms on the surface of the carbon anode. Whether the anode is made of graphitic or nongraphitic carbon, the surface film acts as a solid/electrolyte interface, the nature of which is critical to low-temperature performance. Desirably, the surface film would exert a protective effect yet would remain conductive to lithium ions to facilitate intercalation of lithium. The effect of the lithium alkoxide

additive is to render the surface film more favorable in these respects.

- This results in the formation of asymmetric carbonates via a disproportionation reaction, such as ethyl methyl carbonate in the electrolyte solution described above. Thus, this approach represents a novel method of introducing asymmetric carbonates, which have been identified as being beneficial to low-temperature characteristics, into electrolyte formulations.

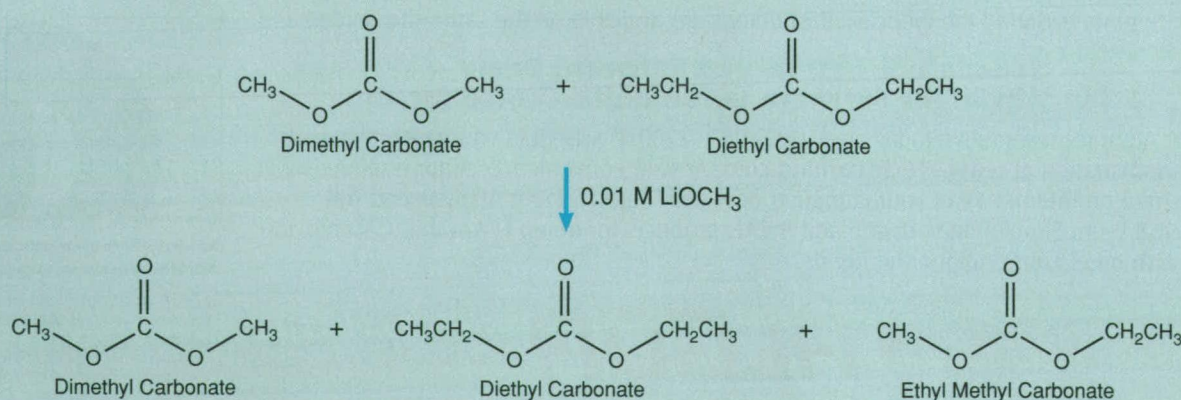
This work was done by Marshall Smart, Ratnakumar Bugga, and Subbarao Surampudi of Caltech for NASA's Jet Propulsion Laboratory. For further information, access the Technical Support Package (TSP) free online at www.nasatech.com under the Materials category.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to

Technology Reporting Office
JPL

Mail Stop 122-116
4800 Oak Grove Drive
Pasadena, CA 91109
(818) 354-2240

Refer to NPO-20607, volume and number of this NASA Tech Briefs issue, and the page number.



The Formation of Asymmetric Carbonates from a solvent mixture of symmetric aliphatic carbonates is facilitated (catalyzed) by a lithium alkoxide additive — in this case, lithium methoxide.

Aliphatic Ester Electrolyte Additives for Lithium-Ion Cells

Higher-molecular-weight esters show promise for extending lower temperature limits.

NASA's Jet Propulsion Laboratory, Pasadena, California

Aliphatic esters have been found to be useful as electrolyte additives for improving the low-temperature performances of rechargeable lithium-ion electrochemical cells. The discovery of the beneficial effects of these additives was made during continuing research directed toward extending the lower limit of operating temperatures of these cells. Other aspects of this research have been described in the immediately preceding article and in prior NASA Tech Briefs articles referenced therein.

In experiments, the effects of aliphatic esters as additives were investigated with respect to a baseline optimal electrolyte formulation described in the noted previous articles; namely, a 1.0 M solution of LiPF_6 in a solvent that consists of equal volume parts of ethylene carbonate (EC), dimethyl carbonate (DMC), and diethyl carbonate (DEC). In order of increasing molecular weight, the aliphatic esters investigated were methyl formate (MF), methyl acetate (MA), ethyl acetate (EA), ethyl propionate (EP), and ethyl butyrate (EB). These esters have freezing temperatures ranging from -73 to -98°C — lower than the freezing temperatures of the carbonate solvents. They are fully miscible into the

baseline electrolyte solution. In each case, the volume proportion of aliphatic ester incorporated into the electrolyte was equal to the volume proportion of one of the carbonate solvents.

The experiments included measurements of the temperature-dependent electrical conductivities of the ester-con-

taining electrolytes, the greatest increase occurring in the cases of the esters of lowest molecular weight (see figure). However, the films formed in the presence of the higher-molecular-weight esters were found to be more stable and to exhibit better kinetics for lithium intercalation/de-intercalation, especially at lower temperatures. Taking both of these trends into account, it appears that the higher-molecular-weight esters are more promising as electrolyte additives.

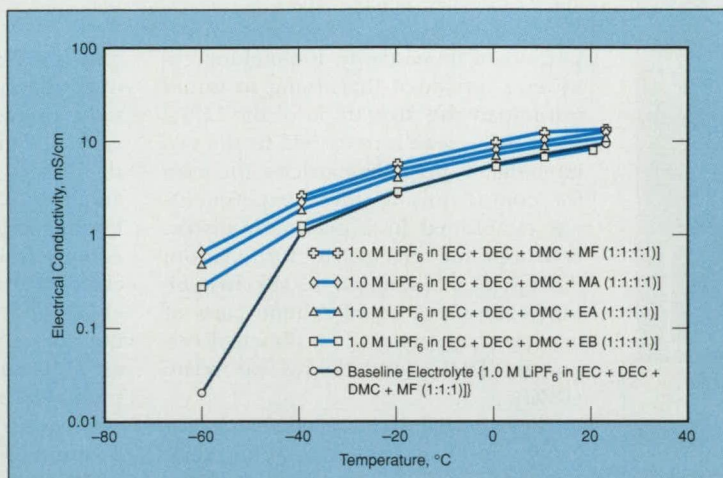
This work was done by Marshall Smart, Ratnakumar Bugga, and Subbarao Surampudi of Caltech for NASA's Jet Propulsion Laboratory. For further information, access the Technical Support Package (TSP) free on-line at www.nasa.gov under the Materials category.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial

use should be addressed to Technology Reporting Office JPL

Mail Stop 122-116
4800 Oak Grove Drive
Pasadena, CA 91109
(818) 354-2240

Refer to NPO-20601, volume and number of this NASA Tech Briefs issue, and the page number.



Electrical Conductivities Are Increased beyond that of the baseline electrolyte by the addition of aliphatic esters. Although the greatest increase of conductivity shown here occurs in the case of the ester of lowest molecular weight, other considerations favor the selection of the higher-molecular weight esters.

taining electrolytes, charge/discharge tests of lithium/graphite half cells containing these electrolytes, and ac-impedance and dc-micropolarization tests to determine the effects of electrolyte compositions on the electrochemical characteristics of films that formed on the graphite electrodes. The low-temperature electrical conductivities of the electrolytes were found to be increased by

Ethyl Methyl Carbonate as a Cosolvent for Lithium-Ion Cells

A low freezing temperature and low viscosity contribute to low-temperature performance.

NASA's Jet Propulsion Laboratory, Pasadena, California

Ethyl methyl carbonate (EMC) has been found to be a suitable cosolvent, along with three other carbonate solvents, for incorporation into electrolytes to enhance the low-temperature performance of rechargeable lithium-ion electrochemical cells. EMC is an asymmetric aliphatic carbonate, and, as noted in the first of the two immediately preceding articles, asymmetric carbonates confer certain benefits. In the research de-

scribed in that article, the asymmetric carbonates were formed *in situ*, in reactions catalyzed by lithium alkoxide additives. In contrast, the present finding that EMC is a suitable cosolvent was made by following a different approach; namely, formulating the electrolyte solvents to include an asymmetric aliphatic carbonate — EMC — in the first place.

The table shows the compositions of electrolytes used in experiments on the

effects of using EMC as a cosolvent. These compositions were chosen on the basis of the expectation of the beneficial effects of adding a low-viscosity, low-melting-temperature solvent (in this case, EMC) to carbonate solvent mixtures that had previously been observed to have desirable stabilizing and passivating qualities. Another purpose for some of the choices was to minimize the proportion of EC and maximize the pro-

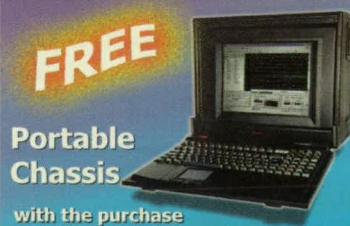
14 Bit, 100 MS/s Scope with 1 Gig Memory

14 Bit, 100 MS/s A/D CARD



SFDR > 70 dB

- 14 Bit Resolution
- 100 MS/s A/D Sampling Rate
- 50 MHz Bandwidth
- 1 Giga-sample Acquisition Memory
- Applications include DSL Testing, Jitter Measurement, Radar/Lidar Ultrasonics, Wireless and Antenna research
- SDKs for C/C++, MATLAB, LabVIEW under Win 95/98/NT/2000



FREE
Portable
Chassis

with the purchase
of a CS14100 512M or 1G

offer ends June 30, 2001

CALL 1-800-567-GAGE

GAGE

A Tektronix Technology Company

GAGE APPLIED, INC.

Tel: 800-567-GAGE Fax: 800-780-8411
e-mail: prodinfo@gage-applied.com

Outside U.S. call 514-633-7447 or Fax 514-633-0770

www.gage-applied.com/ad/nasa601.htm

Concentration (Molar) of LiPF ₆ in the Solvent	Composition of Solvent, Volume Proportions of the Constituents Listed Below			
	EC	DEC	DMC	EMC
1.0	1	1	1	0 (Baseline)
0.75	1	1	1	0
0.75	1	1	1	1
0.75	0.3	0.7	0	0
0.75	0.3	0	0.7	0
1.0	1	1	1	2

These **Electrolyte Compositions** were tested to determine the beneficial effects of incorporating EMC into the carbonate solvent mixture.

portion of low-viscosity, low-melting co-solvents, provided that doing so would not impair the dissolution of the LiPF₆. As in the research described in the two immediately preceding articles, the basis for comparison in these experiments was established by a previously discovered optimal electrolyte formulation; namely, a 1.0 M solution of LiPF₆ in a solvent comprising equal volume parts of ethylene carbonate (EC), dimethyl carbonate (DMC), and diethyl carbonate (DEC).

The experiments included charge/discharge tests of lithium/graphite half cells containing the various electrolytes, and ac-impedance and dc-micropolarization tests to characterize the films [solid/electrolyte interfaces (SEIs)] that formed on the graphite electrodes. The results of the experiments were interpreted in terms of stability of SEIs, kinetics of intercalation of lithium into

graphite electrodes, and electrical conductivities of electrolytes. In the formulations studied, the addition of EMC exerted no observable adverse effects on the SEIs or on the kinetics; instead, the addition of EMC was found to reduce low-temperature film resistances and to enhance the kinetics and the discharge characteristics. The best low-temperature electrical performance was observed in the case of the electrolyte with the highest EMC content; this is consistent with the lower (relative to the other carbonate solvents) viscosity and freezing temperature of EMC.

This work was done by Marshall Smart, Ratnakumar Bugga, and Subbarao Surampudi of Caltech for NASA's Jet Propulsion Laboratory. For further information, access the Technical Support Package (TSP) free online at www.nasatech.com under the Materials category.
NPO-20605

Rechargeable Li-Ion Cells Containing TiS₂ Anodes

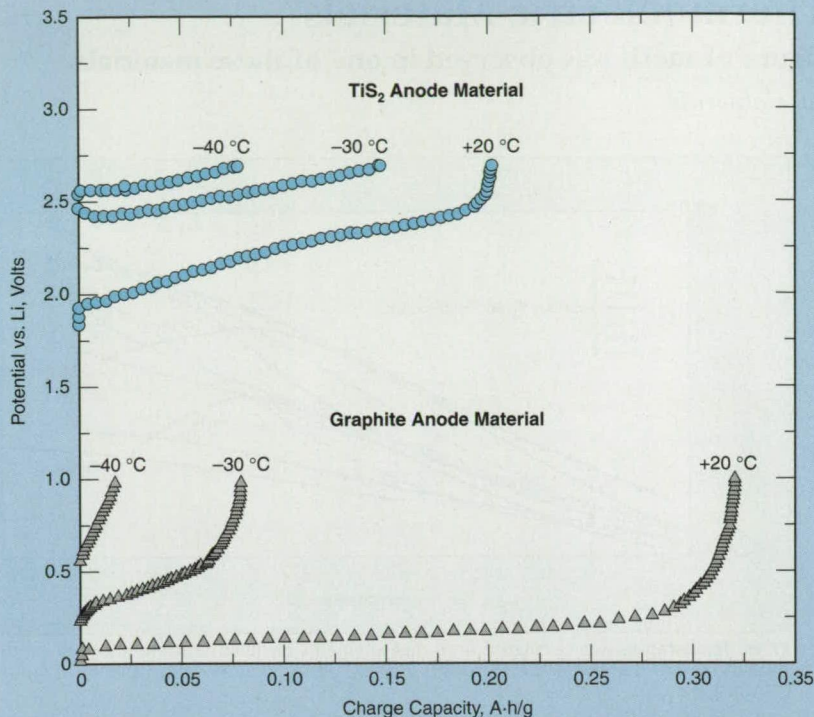
Low-temperature performances exceed those of cells containing graphite anodes.

NASA's Jet Propulsion Laboratory, Pasadena, California

Titanium disulfide has been found to be attractive as an alternative to graphite as the anode material in rechargeable lithium-ion electrochemical cells that are required to operate at temperatures below -20 °C. By using TiS₂ as the anode material, LiCoO₂ as the cathode material, and a suitable low-temperature electrolyte described below, it is possible to construct cells that exhibit superior low-temperature characteristics, including relatively high charge/discharge capacities, capabilities for charging and discharging at relatively high rates, and excellent retention of capacity after

repeated charge/discharge cycling.

The three immediately preceding articles report improvements in electrolytes for low-temperature, rechargeable lithium-ion cells with carbon (usually graphite) anodes. Unfortunately, in cells with carbon anodes, improvements in electrolytes may not be sufficient by themselves; this is because the performances of such cells are limited by high polarization resistances at the carbon anode surfaces. It has been conjectured that the high polarization resistances are due to the slowness, at low temperatures, of diffusion of ions through the



Specific Charge Capacities of TiS₂ and Graphite anode materials were measured at three different temperatures. One measurement (the one on graphite at -30 °C) was made at a current density of 0.04 mA/cm²; all the other measurements were made at a current density of 0.4 mA/cm².

graphite bulk and through surface films (solid/electrolyte interphase) that form on carbon anodes and freeze at low temperatures. Among other things, high polarization resistances make it necessary to charge and discharge at low rates — in some cases as low as $I = C/100$, where I is the charge or discharge current in amperes and C is the nominal charge capacity in ampere-hours.

Two major reasons for choosing TiS₂ as a candidate alternative anode material are that (1) the diffusivity of Li in TiS₂ is high and (2) solid/electrolyte interphases are not expected to form on the surfaces of TiS₂ electrodes because the voltage of TiS₂ versus Li in the fully discharged condition (1.7 V) lies within the stability window of state-of-the-art electrolytes for lithium-ion cells. Because of reason (2), it is possible to use an electrolyte that contains high concentrations of low-freezing-temperature solvents that would be unsuitable for carbon anodes. One particularly attractive electrolyte turns out to consist of 1 M LiPF₆ in a solvent that comprises ethylene carbonate (EC), diethyl carbonate (DEC), dimethyl carbonate (DMC), and ethyl methyl carbonate (EMC) in volume proportions of 3:5:4:1. This electrolyte was developed by carefully selecting proportions of low-freezing-point solvents to suppress the freezing point; in this case, the specific volume propor-

tions were chosen because the resulting solvent mixture remains liquid down to a temperature of -42.5 °C — below the freezing temperatures of other candidate carbonate solvent mixtures that were also tested.

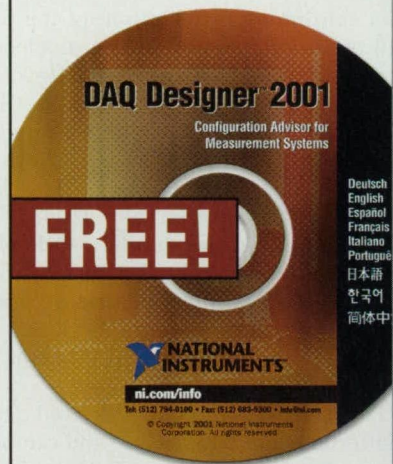
For experiments to quantify the performances of TiS₂ and graphite anodes, half cells with these anodes and lithium counter/reference electrodes were constructed. The cells were tested electrochemically at room temperature (+20 °C) and at temperatures of -30 and -40 °C. The results of the tests (see figure) show that while the graphite anode material exhibits higher specific charge capacity at room temperature, TiS₂ exhibits higher specific charge capacity at the lower test temperatures.

In another experiment, a full cell containing a TiS₂ anode and an LiCoO₂ cathode was constructed and demonstrated to operate at an average potential of about 1.8 V at room temperature. No information on low-temperature tests of this cell was available at the time of writing this article.

This work was done by Chen-Kuo Huang and Jeffrey Sakamoto of Caltech for NASA's Jet Propulsion Laboratory. For further information, access the Technical Support Package (TSP) free on-line at www.nasatech.com under the Materials category.

NPO-20544

Configure Your Measurement System



Use **DAQ Designer™ 2001** to choose products for connecting any signal to your PC or network, including:

- Sensors
- Voltage to 1,000 V
- Current from 0 to 20 mA
- Digital I/O
- Frequency
- Analog and digital cameras
- Controller area network (CAN)

ni.com/info

To run DAQ Designer online or for a free DAQ Designer CD, visit ni.com/info and enter najj21.



(800) 454-2610

Fax: (512) 683-9300 • info@ni.com

© Copyright 2001 National Instruments Corporation. All rights reserved. Product and company names listed are trademarks or trade names of their respective companies.

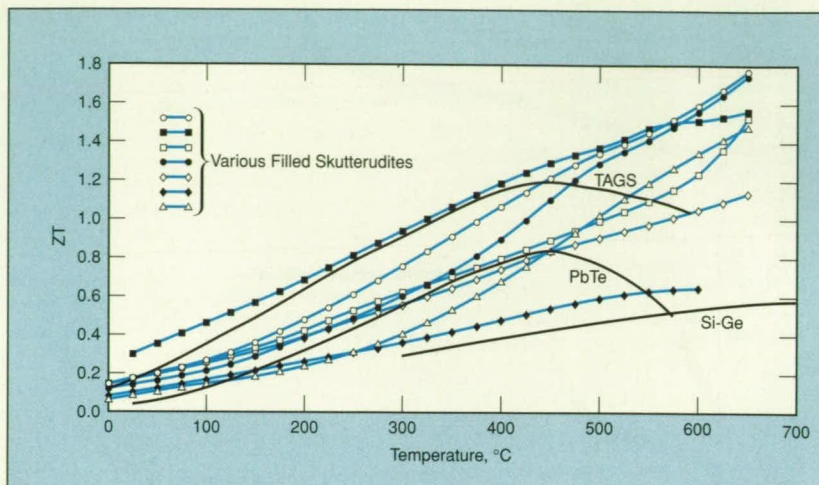
Filled Skutterudites as Thermoelectric Materials

The highest known thermoelectric figure of merit was observed in one of these materials.

NASA's Jet Propulsion Laboratory, Pasadena, California

Filled skutterudites have shown promise as semiconducting materials with superior thermoelectric properties at temperatures up to at least 650 °C. This finding is a breakthrough in a continuing investigation of the potential utility of skutterudites as thermoelectric materials. Previous results of this investigation were reported in several articles in *NASA Tech Briefs*; namely, "Skutterudite Compounds for Power Semiconductor Devices" (NPO-19378), *NASA Tech Briefs*, Vol. 20, No. 3 (March 1996), page 60; "Two Potentially Useful Ternary Skutterudite Compounds" (NPO-19409), *NASA Tech Briefs*, Vol. 20, No. 11 (November 1996), page 66; and "Preparation and Some Properties of n-Type $\text{Ir}_x\text{Co}_{1-x}\text{Sb}_3$ " (NPO-19852), *NASA Tech Briefs*, Vol. 20, No. 11 (November 1996), page 94.

Filled skutterudites are derived from the skutterudite crystal structure and can be represented by the formula $\text{LnT}_4\text{Pn}_{12}$; where "Ln" denotes one of the rare-earth elements La, Ce, Pr, Nd, Sm, Eu, Gd, Th, or U; "T" denotes Fe, Ru, Os, Co, Rh, or Ir; and "Pn" denotes one of the pnictogen elements P, As, or Sb. A skutterudite is said to be filled when empty octants in the skutterudite structure of T_4Pn_{12} are filled with rare-earth atoms.



ZT vs. Temperature was calculated from measurements on filled skutterudites and on three state-of-the-art thermoelectric materials; namely, PbTe, a Si/Ge alloy, and a Te/Ag/Ge/Sb ("TAGS") alloy.

Some of the filled skutterudites of various compositions prepared by a combination of melting and powder-metallurgy techniques have shown exceptional thermoelectric properties in the temperature range of 350 to 700 °C. Both p-type (electron-acceptor) and n-type (electron-donor) conductivities have been obtained; this is fortunate in that to be functional, a thermoelectric device must contain layers of both types.

The thermoelectric figure of merit, ZT , is given by $ZT = S^2 T / \rho \lambda$, where S is the Seebeck coefficient, T is the absolute temperature, ρ is the electrical resistivity, and λ is the thermal conductivity. The figure shows ZT values obtained from measurements on several filled skutterudites and on other, state-of-the-art thermoelectric materials. One specimen exhibited ZT of almost 1.8 at a temperature of 650 °C; this is the highest ZT ever obtained since the beginning of thermoelectric technology in the 1950s. By manipulating the nominal compositions and doping concentrations of filled skutterudites, it may be possible to obtain similarly high ZT at lower and/or higher temperatures. These high-performance thermoelectric materials could be used to make thermoelectric power generators, coolers, and detectors that would operate with efficiencies greater than those of the corresponding devices now in use and could thus be useful in a greater variety of applications.

This work was done by Jean-Pierre Fleurial, Alexander Borishevsky, Thierry Caillat, Donald Morelli, and Gregory Meisner of Caltech for NASA's Jet Propulsion Laboratory. For further information, access the Technical Support Package (TSP) free on-line at www.nasa.gov under the Materials category.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to

Technology Reporting Office

JPL

Mail Stop 249-103

4800 Oak Grove Drive

Pasadena, CA 91109

(818) 354-2240

Refer to NPO-19909, volume and number of this NASA Tech Briefs issue, and the page number.

New



a PROCEQ product from Switzerland

Hardness Tester

EQUOSTAT

MADE IN SWITZERLAND

Precise fast on-site testing of:
small, thin and coated parts.

Can also be used with all EQUOTIP
impact devices.

EQUOTIP ASSOCIATES
P.O. Box 548
Harvey, LA 70059
Ph 504-394-8106
Fax 504-393-9737

EQUOTIP ASSOCIATES



Expendable Composite-Layup Dies From Rapid-Prototype Masters

Small production runs of intricate parts can be accomplished at relatively low cost.

Lyndon B. Johnson Space Center, Houston, Texas

A method that exploits rapid prototyping has been conceived to reduce the time and cost associated with the production of small quantities of composite-material parts that have complex shapes. In this method, mandrels and dies used in forming composite layups are sized and shaped by molding them on rapid-prototype masters and are made of disintegrating mold material (DMM). The method is particularly suitable for manufacturing ventilating air ducts and water ducts for the International Space Station and manifolds and ducts for low-temperature [$<350^{\circ}\text{F}$ ($<177^{\circ}\text{C}$)] fluids in aircraft and other vehicles. For the space program, this method is most advanta-

geous when the quantities desired are low — typically fewer than 10 copies of the same manifold or other design for a specific application.

In a related prior method, master parts are made of plaster; fabrication is difficult, guided by standard paper drawings, and often subject to workmanship errors. In this prior method, plaster is cast against a plaster master part, then split along appropriate lines to create a slush mold. Next, the slush mold is filled with DMM, which is a special plaster. The part thus formed in DMM is then used as a die or mandrel for layup of a composite-material part. The DMM mandrel is not reusable; it must be remade for each part to be

manufactured. The temporal and monetary costs of building the master part and the slush mold and associated tooling are often greater than the other costs of the three or four detailed copies typically manufactured from each master part.

In the present method, neither a plaster master nor a slush mold is used. Instead, a master is made by rapid prototyping. DMM is then cast against the master. Once the DMM has been cured, the workpiece is placed in an oven at a temperature 225°F (107°C). When the DMM has been softened by heating, it is peeled away from the master. The resulting piece of DMM becomes a mandrel or mold that can be used in the custom-

Mass Flowmeters for Gases

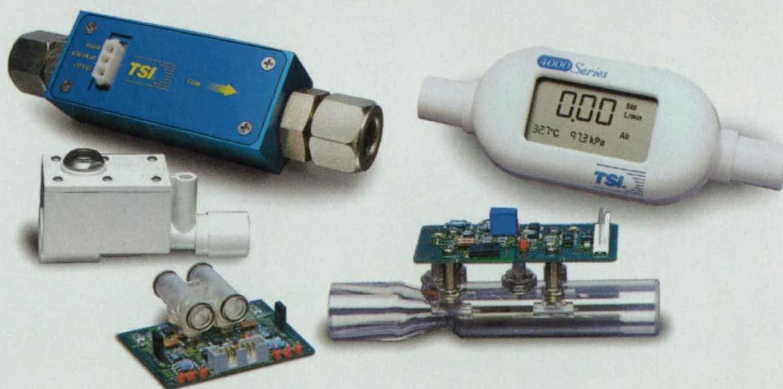
High performance
flowmeters that feature

FAST RESPONSE

LOW PRESSURE DROP

HIGH ACCURACY

AFFORDABLE PRICES



Available in both standard and custom
OEM versions for installed applications
to measure air and other gases.



**TSI Incorporated
Flowmeter Products**
St. Paul, Minnesota, USA

Tel.: 651 490 3849
Fax.: 651 490 4053
Email: flowmeters@tsi.com
Web: <http://flowmeters.tsi.com>

ary manner for fabricating the desired composite-material part.

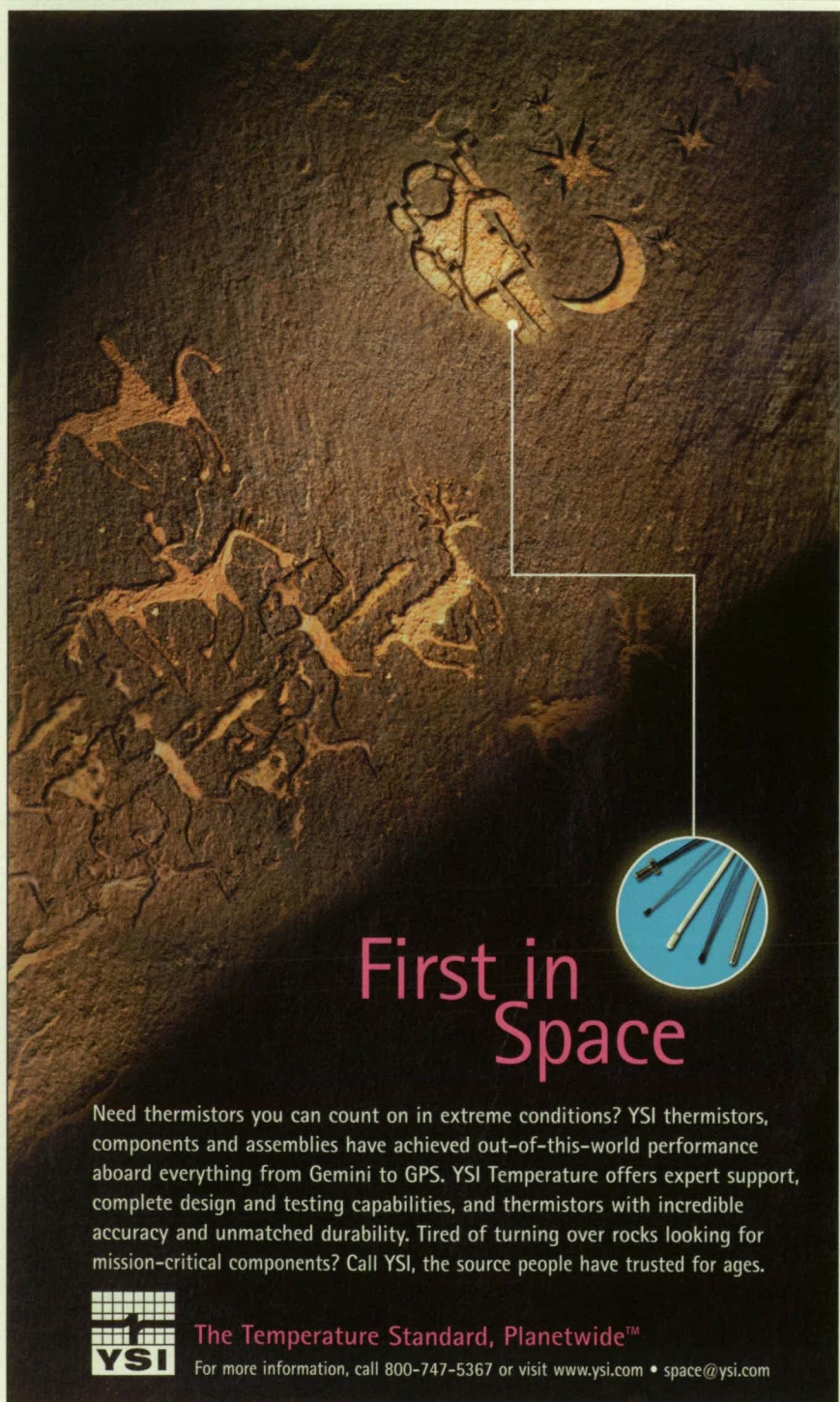
In comparison with the prior method, the present method saves considerable time and money. These savings are attributable mostly to elimination of the slush molds and associated tooling. In one application at Johnson Space Center, the method was found to cut weeks off the time needed to build the first part and to reduce the cost of the part by more than \$8,000. The present method also affords greater accuracy, tolerances of ± 0.005 in. (≈ 0.13 mm)

being normal. The present method also eliminates the need for reworking masters because the rapid-prototype masters are made from computer-aided-drawing data. The total saving, relative to the prior method, is expected to amount to about 75 percent; this translates to $> \$240,000$ per year at NASA's Palmdale, California site alone.

The present method has also been considered for use in a Marshall Space Flight center program in which a few composite-material parts are fabricated by, among other things, wrapping tapes


directly on a stereolithographic master. The present method has shown potential to enhance the program by making it possible to reduce the number of steps in fabricating the master and increasing the accuracy of the master.

This work was done by Robert E. Clark, E. Wayne Shick, Ernest L. Broaden, and Fernando Schemel of Boeing North American, Inc., for Johnson Space Center. For further information, contact the Johnson Space Center Commercial Technology Office at (281)483-0474. MSC-22928



First in Space

Need thermistors you can count on in extreme conditions? YSI thermistors, components and assemblies have achieved out-of-this-world performance aboard everything from Gemini to GPS. YSI Temperature offers expert support, complete design and testing capabilities, and thermistors with incredible accuracy and unmatched durability. Tired of turning over rocks looking for mission-critical components? Call YSI, the source people have trusted for ages.



The Temperature Standard, Planetwide™

For more information, call 800-747-5367 or visit www.ysi.com • space@ysi.com

Punches and Dies for Rounding Corners of Metal Sheets

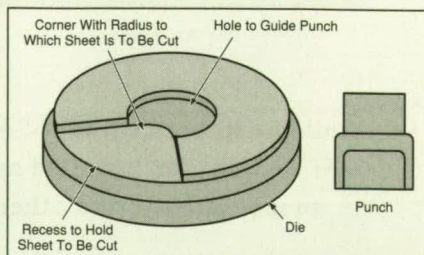
Corners can be formed to desired radii without sawing, snipping, or filing.

Ames Research Center, Moffett Field, California

Punch-and-die sets have been designed for use in rounding corners of rectangular metal sheets to specified radii. One of the traditional procedures for rounding a corner on a rectangular metal sheet is to first make a rough cut with a band saw and/or hand metal snips, then to file the roughly cut edge; this procedure is time-consuming and does not result in an accurate radius. The use of a punch-and-die set of the present type takes less time and results in a corner with an accurate radius.

The figure shows a punch and die of the present type. Of course, the dimensions of the punch and die must be chosen to suit the thickness of the metal sheet and the corner radius to be formed. Thus far, punch-and-die sets have been made for sheet thicknesses up to 0.125 in. (≈ 3.2 mm) and corner radii from 0.2 to 2 in. (≈ 5 to 51 mm).

This work was done by Cecil L. Wachsman of Ames Research Center. For further information, access the Technical Support Package (TSP) free on-line at www.nasatech.com under the Manufacturing/Fabrication category. ARC-14230



The Punch-and-Die can be used to cut a corner of a rectangular metal sheet to a desired radius. This is a simplified drawing; some details have been omitted for clarity in depicting basic shapes.



Model of Pyrolysis of Biomass in a Fluidized-Bed Reactor

Complex dynamics and heat transfer are represented more realistically than in prior models.

NASA's Jet Propulsion Laboratory, Pasadena, California

A mathematical model has been formulated to describe the pyrolysis of biomass in a bubbling fluidized-bed reactor. The reactor is a vertical cylinder that contains a mixture of biomass particles and sand. Superheated steam enters the reactor through holes in the bottom and flows out freely at the top. The sand is a high heat capacity medium used for heating the biomass. The biomass particles, initially at room temperature, are introduced into the already hot reactor and become heated primarily through contact with the sand. Upon reaching a threshold temperature, the biomass particles undergo chemical reactions, the gaseous products of which are carried away by the flow of steam. The "bubbles"

are regions of the fluidized bed that are mostly devoid of particles; these regions occur as a result of the interaction of the turbulent gaseous flow with the particles.

The mathematical model is one of multiphase flow. The mixture of biomass and sand is regarded as a particulate phase divided into two classes of particles that interact with a flowing gas phase. Initially, the solid biomass is regarded as consisting of three chemical species: cellulose, hemicellulose, and lignin. From each of these initial species, two new solid species are generated during pyrolysis: an "active" species and a char. The gas phase is regarded as consisting of the original carrier gas (steam), plus tar and gas that are generated through pyrolysis.

The model includes equations for the conservation of mass, momentum, enthalpy, and chemical species. The conservation equations for the particles are derived from the Boltzmann equations through ensemble averaging. The particulate-phase stresses are expressed as a tensor sum of collisional and Reynolds contributions; contributions from collisions between particles of different classes are included. The conservation equations for the gaseous phase are the Navier-Stokes equations augmented by the species and energy equations and by the perfect gas law. A distinctive feature of these equations are the source/sink terms portraying the dynamic interaction between particles and gas phase.

Don't Crack Under Pressure. Get Tuf...

With NanoTuf™ Coatings

Superior Abrasion and Chemical Resistant Coatings for Eyewear and Transparent Surface Applications

NanoTuf™ is more abrasion-resistant than other polymer coatings with proven resistance to chemicals and flame. NanoTuf™ coated surfaces won't crack or shatter upon impact and can be used in a wide range of transparency applications.

Triton Systems, Inc. has successful, proven experience in the research, development, and delivery of advanced materials. Our flexible approach and unique processes in working with our customers enables us to meet their toughest requirements.

Call 978-250-4200 or email nanotuf@tritonsystems.com today for more information.

Military and Commercial Applications Include:

Protective Eyewear:
visors, goggles,
spectacles

Specialty Eyewear:
sports, ophthalmic,
sunglasses

Windshields: airplane
and transportation
vehicles

Canopy Coatings

CB Protection



Triton Systems, Inc. • Chelmsford, MA 01824 • Tel: 978-250-4200
Fax: 978-250-4533 • Email: info@tritonsystems.com • Web: www.tritonsystems.com

Stresses in the gaseous phase are expressed as the sum of Newtonian and Reynolds (turbulent) contributions. Transfer of heat between phases, and between particles in various classes (e.g., as a result of collisions between biomass and sand particles) is taken into account.

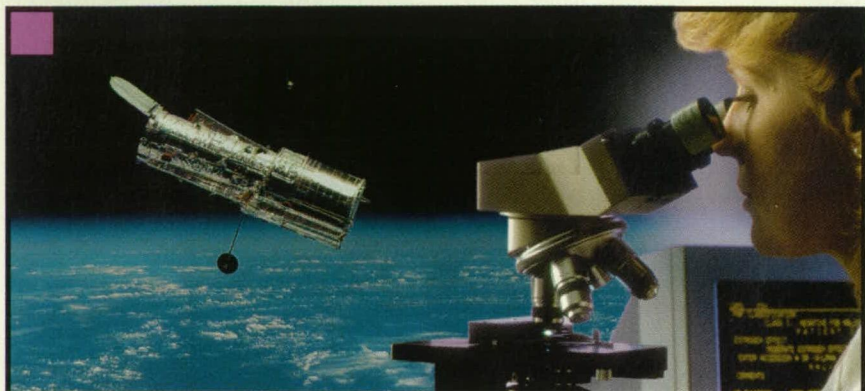
Unlike most models of turbulent flows of gases in fluidized beds, this model does not contain the Boussinesq approximation, which would imply that the stress and strain-rate tensors are aligned. Such alignment is not consistent with the recirculating flows that occur in fluidized beds. Instead, in this model, turbulence is repre-

sented by the equations of the full differential Reynolds stress model (DRSM) for two-phase flows. Some of the terms in the DRSM equations are mathematical sub-models that have yet to be defined. It will be necessary to complete the modeling of Reynolds stresses for both the gaseous and the particulate phases in order to close the system of governing equations.

The model is extremely complex because of the coupled nature of the dynamic and thermodynamic evolution of the phases, and because of the turbulent features of the gaseous carrier and particulate flows. Because many of the aspects of

the model are novel, it is expected that the first numerical simulations to be performed by use of the model will be those of sand/biomass dynamics in absence of heat transfer, turbulence, or chemical reactions. The results of the first simulations should enable the validation of the parts of the model that represent the dynamic interaction between phases and the particulate stress tensor.

This work was done by Josette Bellan and Danny Lathouwers of Caltech for NASA's Jet Propulsion Laboratory. For further information, access the Technical Support Package (TSP) free on-line at www.nasatech.com under the Physical Sciences category. NPO-20708



Superior image and data transfer... From the furthest star to the smallest microbe.



There are many reasons EDT data/camera interface boards are used in astronomy, medicine,

industry, aerospace — anyplace where exceptional and dependable performance is crucial.

- Exceptional speed, using the computer's own memory for high-speed access.
- Simple and practical designs that easily handle the most

sophisticated data or camera interface tasks.

- PCI/RCI fiber-optic interface available on several models for flawless image transfer and total flexibility in locating your computer.
- Engineering customer-support that ensures seamless integration of your system.

Wherever your research or innovation takes you, contact EDT today and see how our products provide the extraordinary interface performance your work demands.

EDT

Engineering Design Team, Inc.

1100 NW Compton Dr., Suite 306, Beaverton, Oregon 97006
Phone: 1-800-435-4320 • Fax: (503) 690-1243
email: info@edt.com • www.edt.com

System for Delivering Gas Samples to Multiple Instruments

John F. Kennedy Space Center, Florida

A system that samples gases at multiple remote locations and delivers the gases to two or possibly more gas-monitoring instruments (e.g., mass spectrometers) has been developed. The system includes a transport (suction) pump that draws the gases from the sampling locations, through transport tubes, into a plenum, which is large enough to act as a buffer against changes in pressure in the transport tubes. Connected to each transport tube at a location near the plenum are two or more sample tubes that are, in turn, connected to manifolds of sample-selector valves through which gases are drawn into the instruments. Each instrument is equipped with a sampling (suction) pump that draws gas from one of the transport tubes that has been selected by opening the corresponding sample-selector valve. Each sampling pump is operated under feedback flow and pressure control to maintain a steady instrument-inlet pressure needed to ensure stable instrument readings. The sample flow thus diverted from the transport tube is kept to one-fifth or less of the transport flow in order to minimize the perturbation of the transport flow and thus, further, minimize any effect of one instrument on the other.

This work was done by Barry Davis, Carolyn A. Mizell, and Frederick W. Adams of Kennedy Space Center and Timothy Griffin, Curtis M. Lampkin, Guy Naylor, and Richard J. Hritz of Dynacs Engineering Co., Inc. For further information, access the Technical Support Package (TSP) free on-line at www.nasatech.com under the Physical Sciences category. KSC-12123

Atmospheric Source of Atomic Oxygen for Cleaning Paintings

A vacuum chamber is no longer necessary.

John H. Glenn Research Center,
Cleveland, Ohio

A portable apparatus that operates at atmospheric pressure generates a beam of monatomic oxygen. The apparatus is designed to be used in a dry, noncontact process for removing organic contaminants from the surfaces of paintings. Organic contaminants that can be wholly or partly removed by use of this apparatus include some deposited in acts of defacement (e.g., lipstick and marks left by felt-tip and ball-point pens) and some deposited from fire (e.g., soot and charred binder). In some cases, this apparatus may make it possible to restore works of art that were previously counted as lost.

The use of monatomic oxygen to remove undesired organic materials from the surfaces of paintings was reported in several articles in previous issues of *NASA Tech Briefs*; namely, "Atomic Oxygen Removes Varnish and Lacquer From Old Paintings" (LEW-16031), Vol. 20, No. 4 (April 1996), page 61; and "Cleaning Soot From Oil Paintings With Monatomic Oxygen" (LEW-15896), *NASA Tech Briefs*, Vol. 20, No. 10 (October 1996), page 110. Monatomic oxygen reacts with carbonaceous deposits on the surfaces of paintings, converting the carbon to CO and CO₂ and converting any hydrogen content of the deposit to H₂O vapor. Conventional techniques for cleaning paintings involve the use of solvents, which are not effective in some defacement cases and cases of severe fire damage. In contrast, the use of monatomic oxygen causes the removal of carbonaceous deposits at controlled rates, and cleaning can be stopped at any point.

The cited prior articles describe placing each painting to be cleaned in a vacuum chamber, where it was exposed to monatomic oxygen from either a plasma or a beam source. The present atmospheric-pressure apparatus makes a vacuum chamber unnecessary. In this apparatus, monatomic oxygen is generated in a dc arc in a mixture of oxygen flowing at rate of 0.1 to 0.2 L/min and helium flowing at a rate of 4.3 L/min. The role of the helium is to inhibit the recombination of monatomic oxygen into diatomic oxygen.



Combine the SBC6711 with multiple OMNIBUS modules to custom tailor your embedded solution!

	Analog Input	Analog Output
A4D4	4 Ch. 16-bit 0-200 kHz	4 Ch. 16-bit 0-200 kHz
A4D1	4 Ch. 14-bit 0-10 MHz	1 Ch. 14-bit 0-10 MHz
A16D2	16 Ch. 16-bit 0-195 kHz	
AD16	2 Ch. 12-bit 0-40 MHz	
AD40	4 Ch. 16-bit 0-2.5 MHz	
MOT		4 Ch. 16-bit 0-200 kHz
RF	2 Ch. 12-bit 0-65 MHz	2 Ch. 12-bit 0-65 MHz
SD	4 Ch. 24-bit 2-96 kHz	4 Ch. 24-bit 30-96 kHz
Servo16	16 Ch. 16-bit 0-100 kHz	16 Ch. 16-bit 0-100 kHz

OMNIBUS Modules



www.innovative-dsp.com
805.520.3300 phone • 805.579.1730 fax

Looking for Mr. Right?

Single Board Computer, strong, independent, flexible, green, 160mm x 100mm, USB, 150 MHz DSP, 2 OMNIBUS sites seeks long term relationship with intelligent end-user. Call anytime 805-520-3300.

Features

- ▶ 150 MHz TMS320C6711 floating-point DSP
- ▶ Operates independently from a host PC
- ▶ Plug-n-Play USB interface
- ▶ Dual OMNIBUS I/O Module sites
- ▶ Comprehensive C/C++ cross development tools & servo algorithm templates
- ▶ Windows 9x/NT/2000 drivers

Applications

- ▶ Noise Cancellation
- ▶ Embedded Control
- ▶ Wide-Channel Audio
- ▶ Precision Motion Control

SBC6711



Call for special OEM pricing and custom configuration!

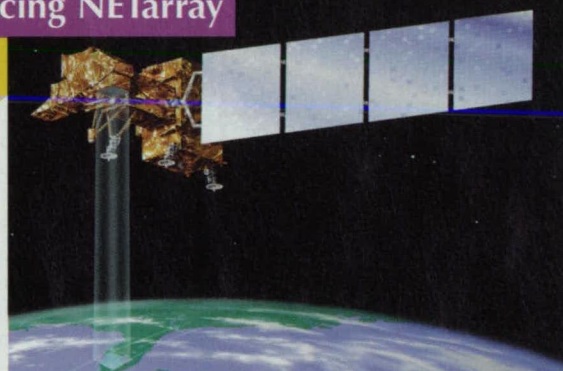
For More Information Circle No. 441

Now Introducing NETarray



Program Successes:

- ETRAC
- SAIP
- JSAS
- LANDSAT-7
- CIP
- TIS
- MIES
- EDOS
- JSTARS
- PEG
- CARS
- JSIPS-N
- PTW
- DISW-A
- NIMA IPL
- LLNL
- NASA SRTM



no one has more experience in
storing the real world.

Capture, process and display real-time data with direct attached and networked **storage solutions** from Ciprico.

Get the **performance** you want and the **technology** you need with our **easy to install COTS** (commercial-off-the-shelf) storage systems. Ciprico has over 20 years **experience** in designing high-speed image data storage. You can count on that same expertise in our **Fibre Channel SAN** infrastructures.

For more information, visit our website at **www.ciprico.com** or call 1.800.727.4669.



2800 Campus Drive,
Plymouth, Minnesota 55441
763.551.4000 • Fax: 763.551.4002

POSITIONING SLIDES AND XY TABLES

✓ Manual linear and rotary motion for scanning & indexing
✓ Over 747 Models

✓ OEM Modular Fixtures
✓ Move up to 90"

Free Catalog
800 642-6446
or 716 657-6151
www.velmex.com/b

BUY
FACTORY
DIRECT

VELMEX, INC.

For More Information Circle No. 582

Flexible Bladders

NASA Qualified

- BLADDER TANKS & AIR CELLS
- DIAPHRAGMS & ACTUATORS
- BELLOWES & FUEL CELLS
- STRESS TEST BLADDERS
- CUSTOM INFLATABLES
- PNEUMATIC / HYDRAULIC PRESSES

AERO

800-526-5330

AERO TEC LABORATORIES INC.

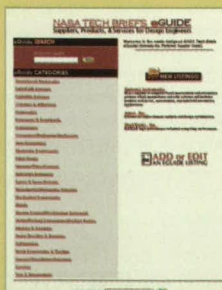
RAMSEY, NJ 07446-1251 USA
TEL: 201-825-1400 • FAX: 201-825-1962
e-Mail aerotec@cybernex.net
<http://www.atlinc.com>

For More Information Circle No. 583

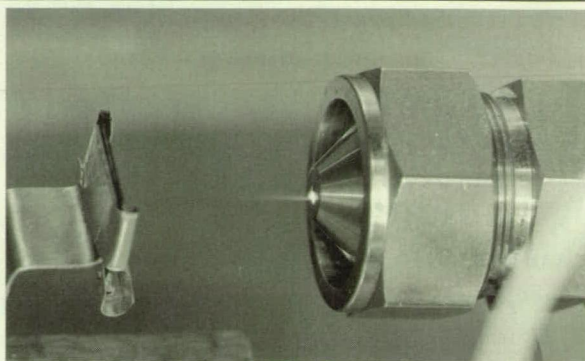
NOW IT'S eASY TO FIND eENGINEERING TOOLS WITH eGUIDE

NASA Tech Briefs' NEW online guide to suppliers, products, and services for design engineers.

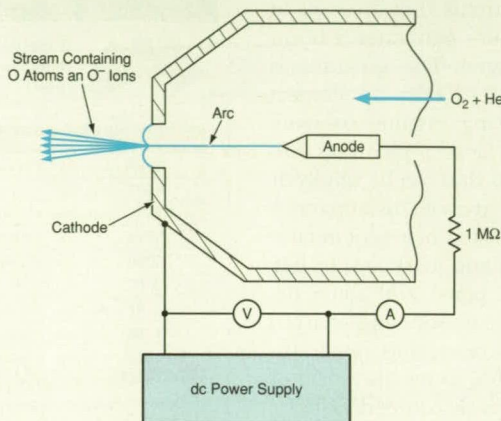
- Search by keyword or within 25+ product categories
- Link directly to company web sites
- Locate B2B suppliers and sites offering e-commerce



www.nasatech.com/eguide



PHOTOGRAPH SHOWING SAMPLE HOLDER FACING ATOMIC-OXYGEN SOURCE



SCHEMATIC DIAGRAM

Figure 1. A Stream That Contains O Atoms and O⁺ Ions is generated in a dc arc in a flowing He/O₂ mixture.

The arc is struck between (1) a cathode in the form of a stainless-steel disk containing a 3.175-mm-diameter circular orifice on a truncated cone at one end of a plenum through which the gas mixture flows and (2) an anode in the form of a tungsten needle inside the plenum, 1.6 mm upstream from the orifice. The arc is powered by a 7-kVdc supply in series with a 1-M Ω current-limiting resistor. The arc is blown through the orifice, giving rise to a stream of oxygen ions and charge-exchange neutral oxygen atoms that are propelled about 1 cm downstream from the orifice. These oxygen species can react with organic materials exposed to the stream.

A painting to be cleaned is typically placed about 8 mm downstream from the orifice. Because the spot that is cleaned by exposure to the stream is only 3 to 5 mm wide, it is necessary to translate the apparatus gradually along the painting surface to clean a larger area. The apparatus was used to clean lipstick defacement from an Andy Warhol painting. As shown in Figure 2, the lipstick was completely removed.

This work was done by Bruce A. Banks and Sharon K. Rutledge of Glenn Research Center and Edward Sechkar and Thomas Stueber of Dynacs Engineering Co., Inc. For further information, access the Technical Support Package (TSP) free on-line at

www.nasatech.com under the Physical Sciences category.

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Commercial Technology Office, Attn: Steve Fedor, Mail Stop 4-8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-16971.

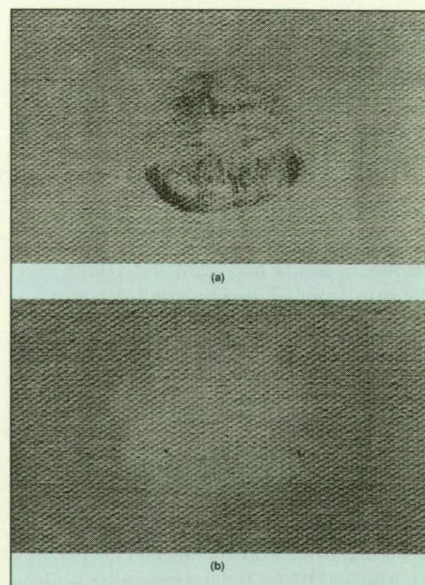
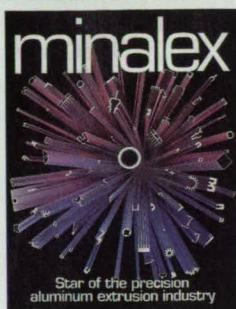


Figure 2. The Effectiveness of Lipstick Smudge Removal on Andy Warhol's painting, "Bathtub," is shown in closeup photographs: (a) Before atomic oxygen cleaning and (b) after atomic oxygen cleaning.



PRECISION ALUMINUM EXTRUSIONS

New! An informative brochure from MINALEX, leader in close tolerance shapes to 3 1/2", illustrates typical applications and describes capabilities including short runs. MINALEX, quality leader, delivers on time, every time. MINALEX, PO Box 247, Whitehouse Station, NJ 08889; Tel: 908-534-4044; Fax: 908-534-6788.

Minalex

For More Information Circle No. 601



SELF-COMPENSATED LIQUID LEVELS

Patented Model 187 Self-Compensated Liquid Level instrument uses capacitance-based technology to address errors in level measurements due to changing liquid/gas compositions, pressures, temperatures and densities inside a vessel. The instrument continuously monitors a gas and liquid reference sensors, as well as a linear sensor which spans the vessel height. Call 865-482-4056. American Magnetics, Inc.; email: sales@americanmagnetics.com; website: www.americanmagnetics.com

American Magnetics, Inc.

For More Information Circle No. 602



SOFTWARE SHOWCASE

Software Showcase provides you with information and demonstrations of industry-leading National Instruments application software for measurement and automation applications, such as LabVIEW™, LabWindows™/CVI, Lookout™, HiQ™, and much more. The free multimedia CD also offers direct access to product and order information via the Internet. Call or visit the National Instruments Web site for your free CD! National Instruments; Tel: 800-433-3488 (U.S. and Canada); 512-794-0100; Fax: 512-683-9300; e-mail: info@ni.com; www.ni.com/info/showcase

National Instruments

For More Information Circle No. 603

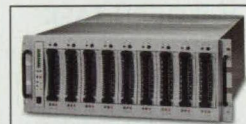


GAS-TUBE CATALOG

Extensive application and technical information on the use of gas tubes as over-voltage protectors, triggers, igniters and indicators is contained in Lumex's Gas Tube catalog. Indicators are available in a range of colors. Surge arrestors protect I.C., telephone, data and signal circuits from electro-static charges, switching surges and lighting inductive currents - while a new line of protector-pack devices insulate AC or DC lines in low-voltage boards, power conditioning equipment, automotive, aircraft and similar products. For more information, please visit www.gastubes.net. Lumex, Inc., Palatine, IL 60067; Tel: 800-278-6666; Fax: 847-359-8904; website: www.lumex.com; email: sales@lumex.com

Lumex Inc.

For More Information Circle No. 604



SCSI ENCLOSURES

StorCase™ Technology is pleased to announce the release of a new line of external expansion chassis, the InfoStation™ backplane-design SCSI enclosure. Its direct connect backplane supports up to 9 high-density, high-speed, 3.5" SCSI single-ended, Ultra2, or Ultra160 SCA devices for RAID or JBOD applications. With upgrade slots for adding RAID and SAFE controller modules, the InfoStation is ready for the future when you are. StorCase Technology, a Kingston Technology Co.; www.storcase.com

StorCase Technology, Inc.

For More Information Circle No. 605



LO-COG® DC GEARMOTORS (BULLETIN LCG)

Pittman brand LO-COG® brush-commutated DC gearmotors offer smooth, quiet operation and long life. LO-COG® gearmotors feature sintered steel spur gears and are available with several reduction ratios and torque rating to provide an economical solution for a wide range of applications. An innovative cartridge brush assembly reduces audible and electrical noise and significantly improves brush life by maintaining optimum brush force throughout the life of the motor. Pittman - A PennEngineering Company; Tel: 877-PITTMAN (877-748-8626); Fax: 215-256-1338; website: www.pittmanner.com

Pittman

For More Information Circle No. 606



PATENTED SELF-LOCKING CLAMPING SYSTEM

New Amacoil datasheet covers patented, GripFast™ clamping system that enables fast-action, secure attachment and quick release for a wide variety of items on a smooth, unhardened shaft. The GripFast self-locking collar fastening system is designed to increase production and decrease downtime in spooling, fastening, joining, machine tooling and other applications. Amacoil, Inc.; Tel: 800-252-2645; e-mail: amacoil@aol.com; www.amacoil.com

Amacoil, Inc.

For More Information Circle No. 607

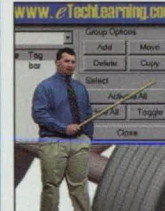


FMEA SOFTWARE

Failure Modes and Effects Analysis using FMEA-Pro 5 empowers automotive, consumer, electronic, aerospace, defense and general manufacturing industries to improve the quality, reliability and safety of their products. This fully customizable, software helps companies comply with QS 9000, ISO 9000, SAE J1739, MIL-STD-1629, ISO/TS 16949 and other regulations. FMEA-Pro 5 contains extensive libraries and data protection features. The report generation tools support a variety of file formats, including HTML and PDF. Download a free trial: www.fmeasoftware.com.

Dyadem International Ltd.

For More Information Circle No. 608

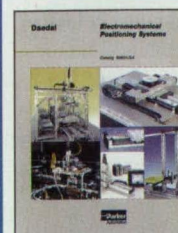


TUESDAY @ TEN: INTERNET TV DISTANCE DEMOS SHOW WHAT'S NEW

Join Algor every Tuesday at 10 a.m. Eastern Time at www.eTechLearning.com to learn about Algor's Finite Element Analysis and full Mechanical Event Simulation software and its InCAD products for doing FEA within CAD. Viewers can phone or e-mail questions to be answered by Algor engineers during these free, public Webcasts. Replays are available on demand. Phone: (412) 967-2700; E-mail: info@algor.com; or Fax: (412) 967-2781; www.eTechLearning.com, www.algor.com

Algor, Inc.

For More Information Circle No. 609



ELECTRO-MECHANICAL POSITIONING SYSTEMS

Complete systems, sub-systems, or component products are offered at selectable levels of integration in this comprehensive guide to positioning and motion control. A full spectrum of automation products including single axis tables, linear motor systems, and high speed gantry robots, provides "best fit" solutions for automation applications. Parker Hannifin Corp., Daedal Division; Tel: 877-772-0205; e-mail: ddi007@parker.com; www.phdaedal.com/tblf

Parker Hannifin Corp., Daedal Division

For More Information Circle No. 610



ELECTRONIC CATALOG

New sizes just added! Free software is now available that allows engineers to search through thousands of standard retaining rings and wave springs. Utilize interactive design wizards to create custom rings and springs, and input assembly parameters to calculate thrust capacity, maximum rpm and stress. Smalley Steel Ring Company, 385 Gilman Ave., Wheeling, IL 60090; Tel: 847-537-7600; Fax: 847-537-7698; website: www.smalley.com; email: info@smalley.com

Smalley Steel Ring Company

For More Information Circle No. 611



RESEARCH CHEMICAL, METALS AND MATERIALS CATALOG

The new 2001/02 catalog contains the entire Alfa Aesar product range in a single "All-in-One" edition. The catalog carries nearly 25,000 products, including inorganic and organic compounds, pure metals and elements, alloys precious metal compounds and catalysts, rare earths, analytical products, labware and more. Includes nearly 3,000 new products. Alfa Aesar - A Johnson Matthey Company, 30 Bond St., Ward Hill, MA 01835; Tel: 800-343-0660; Fax: 800-322-4757; email: info@alfa.com; Try our online catalog at www.alfa.com

Alfa Aesar

For More Information Circle No. 612



MICRO-METALLIZER PLATING PROCESS

Low-Cost Disposable Applicators permit instantaneous selection from a variety of plating possibilities without preparation of solutions. Applications include goldfinger repair & rework, electronic instrument repair, prototype development work, etc. Available solutions: gold, silver, copper, nickel, palladium, rhodium, tin, zinc, chrome-color, black nickel. Hunter Products, Inc., Bridgewater, NJ 08807; Tel: 800-524-0692; Fax: 908-526-8348; website: www.hunterproducts.com; email: hunter@eclipse.net

Hunter Products, Inc.

For More Information Circle No. 613



NEW KEITHLEY SWITCHING HANDBOOK

The 4th Edition of Keithley Instruments' free *Switching Handbook* is now available. This useful reference is designed to help test system developers understand how to reconcile diverse and conflicting switching requirements when designing the switch systems needed to automate their applications. To request a free copy, call Keithley tollfree at 1-888-534-8453 or visit the company's website: www.keithley.com. Keithley Instruments, Inc., 28775 Aurora Road, Cleveland, OH 44139; Tel: 888-534-8453; Fax: 440-248-6168.

Keithley Instruments Inc.

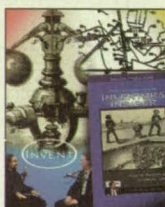
For More Information Circle No. 614



FREE DATA ACQUISITION STARTER KIT

Maybe you've always wanted to try PC-based data acquisition. Or maybe you acquire data now but aren't pleased with the results or performance. Here's your chance to try our solution absolutely FREE. Sign up to receive our WinDAQ Starter Kit that includes data acquisition hardware, and a CD-ROM containing WinDAQ software, a multimedia tutorial, and electronic catalog. Visit DATAQ Instruments on the web at www.dataq.com/nlit to register.

DATAQ Instruments



NEW INVENTORS VIDEOS TEACH LAW & BUSINESS

Save time and money by learning how to patent your ideas, how to build a profitable business, and how to make the law work for you. This premium video series by Patent Attorney Randy Notzen teaches inventors everything from start to finish about patents and inventing. Protect your invention, learn the laws and tricks of the trade. This expanding 10-volume set of informative and easy-to-understand videos is available. Info Line: 888-258-5164, or order online at www.InventorsInsider.com

Inecom, Inc.

For More Information Circle No. 615

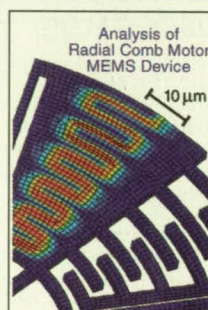


HALOGEN TASK LIGHTS

Sunnex Halogen Task Lights are used for a multitude of OEM applications. They provide "natural" white light, are energy efficient and rugged. A complete range of options allows you to design the specific light for your requirements. You'll find Sunnex lights on machine tools, production machinery, assembly equipment - even on the HUMVEE. Sunnex, Inc., Natick, MA; Tel: 800-445-7869; Fax: 508-651-0099; email: sunnex@sunnex.com; website: www.sunnexonline.com

Sunnex Inc.

For More Information Circle No. 616



ALGOR SIMULATES MEMS

Free Webcasts show MEMS simulation with ALGOR's FEA technology that couples electrostatic analysis and static & dynamic stress analyses, all operated through an easy-to-use interface within CAD that includes model scaling & building tools. Website: mems6.algor.com; email: mems6@algor.com; Tel: 412-967-2700;

ALGOR, Inc.

For More Information Circle No. 617

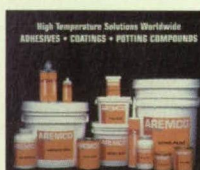


MINIATURE FITTINGS, VALVES AND QUICK DISCONNECTS

New 2001 catalog with many new part numbers and engineering drawings. Beswick specializes in miniature fittings, valves, quick disconnects, and orifices with leak tight o-ring face seals. The 2001 catalog also features an expanded orifice/restrictor section, new low cracking pressure valves, numerous additions to the stainless steel line and much more! Beswick Engineering Co., Inc., Greenland, NH; Tel: 800-354-5014; Fax: 603-433-3313; email: besales@beswick.com; website: www.beswick.com

Beswick Engineering Co., Inc.

For More Information Circle No. 618

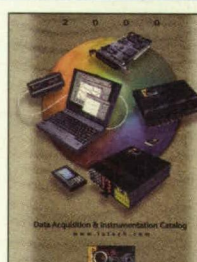


ADHESIVES, COATINGS AND POTTING COMPOUNDS

Since 1965, Aremco Products, Inc. has been a leader in the development and production of high temperature adhesives, coatings, sealants and potting compounds. These advanced materials are used throughout industry in the design of sensors, electrical components and analytical instruments, as well as the maintenance of high temperatures industrial process equipment. Aremco Products, Inc. 707-B Executive Blvd., P.O. Box 517 Valley Cottage, NY 10989; Tel: 845-268-0039; Fax: 845-268-0041; email: aremco@aremco.com; website: www.aremco.com

Aremco Products Inc.

For More Information Circle No. 619



DATA ACQUISITION CATALOG

IOtech's Data Acquisition & Instrumentation Catalog. This free 320-page catalog features our complete line of products pictured for the first time in full color. New products include an Ethernet-based recorder, plug-in PCI board, and temperature and voltage instruments. A wide range of data acquisition systems and signal conditioning options, as well as IEEE 488 instruments and controllers are also featured. IOtech, Inc.; Tel: 440-439-4091; Fax: 440-439-4093; e-mail: sales@iotech.com; www.iotech.com

IOtech, Inc.

For More Information Circle No. 620

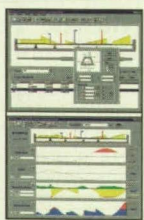


FLOW CHARTING PDQ

Professional people that draw flow charts may hear the noise and see the glitter, but they know Flow Charting PDQ was designed for flowcharting. It is the simple flowcharting program used in quality and manufacturing environments — and used by auditors, attorneys, and engineers. It is actively being used to chart ideas, workflows, and data flow diagrams. Try Us! Download a 15-day trial version at www.patton-patton.com or call 1-800-525-0082.

Patton & Patton Software Corp.

For More Information Circle No. 621



STRESS ANALYSIS MADE EASY

Beam 2D delivers instant, detailed analysis of complex statically indeterminate and determinate beams. Created specifically for mechanical and structural designers, this program is all you need to tackle problems involving multi-support, multi-load, multiple cross-section beams quickly and effortlessly. Features include a pop-up cross-section properties calculator, built-in databases of beam properties, shear deflection analysis, and much more. Price: \$285.00 complete; 90-day no-risk evaluation. Free trial download: www.orandsystems.com. Orand Systems Inc. Tel: 905-569-0055; Fax: 905-569-0045

Orand Systems Inc.

For More Information Circle No. 622



ENVIRONMENTAL MEASUREMENT AND INSTRUMENTATION

The Greencast™ Product Preview from the upcoming OMEGA Volume MM® Environmental Handbook contains a brand new selection of leading edge technology products for Process Measurement and Control from mini-infrared guns with circle dot laser precision, datalogging digital thermometers with dual input features to general test equipment DMM's with interchangeable heads for versatility. Every product can be purchased online. For more information, go to the OMEGA Engineering Inc. web site. OMEGA Engineering Inc. email: info@omega.com; website: www.omega.com

Omega Engineering Inc.

For More Information Circle No. 623



General-Purpose Wavelet Program

This program affords a variety of capabilities that are especially useful in wavelet analysis.

Stennis Space Center, Mississippi

"S+Wavelets" is the name of a computer program that implements a suite of mathematical "tools" for wavelet analysis of signals (including two-dimensional signals that represent images.) Wavelets, being localized in both time and frequency (or space and wave number), serve as means for transforming and extracting information from signals that have temporally or spatially varying properties. In a sense, wavelet methods combine the best features of time and frequency methods (e.g., Fourier-transform methods). Modern wavelet research began in the mid-1980s, but until now, there has been no commercially available, general-purpose software to support rapid prototyping for research on, and application of, wavelets. S+Wavelets satisfies the need for such a computer code.

S+Wavelets provides a variety of transform objects for one- and two-dimensional sets of data, including the following:

- The discrete wavelet transform with orthogonal and biorthogonal wavelets;
- Multiresolution analysis and decompositions;
- Wavelet-packet and cosine-packet transforms with best-basis selection;
- Matching pursuits decompositions;
- Robust and outlier-resistant wavelet transforms;
- Translation-invariant (nondecimated) wavelet transforms;
- Decompositions of signals into atomic waveforms; and
- Estimates of signals through wavelet shrinkage

S+Wavelets is available as part of a software system called "S-PLUS." S+Wavelets supports such basic S-PLUS functions as print, plot, and summary, specializing these features and functions for wavelet objects. Other basic S-PLUS generic functions supported in S+Wavelets include subscript and assignment operators, arithmetic and logical operators, mathematical functions, and a suite of "tools" that assist in visualization of data. The visualization tools include autocorrelation-function plots, box plots, bar plots, dot charts, histograms, and quantile-quantile plots. All of these functions are specialized for wavelet objects; for example, in the case of a discrete wavelet transform, side-by-side box plots would depict wavelet coefficients grouped by resolution levels.

S+Wavelets introduces several new functions that are especially useful for wavelet analysis. These include provisions for displaying a palate of "interesting" views, time-scale and time-vs.-frequency plots, transfer-function plots, evaluation of Fourier transforms of wavelets, plots of energy-concentration efficiencies of waveforms, and plots for visualizing the type of transform basis selected for analysis.

S+Wavelets offers the following other capabilities and features that are important for wavelet analysis:

- Perfect Reconstruction – All transform objects can be inverted to recover original signals to within round-off errors.
- Dual Implementation in S-PLUS and C – Most of the algorithms in S+Wavelets

are implemented in both the S-PLUS and C languages for flexibility and efficiency. The S-PLUS versions are used to make modifications and extensions, while the C versions are ordinarily used to perform computations.

- Ability to Create New Wavelet Filters – Users can create their own wavelets and wavelet filters for use in addition to, or in place of, built-in wavelets and filters.
- Support for Arbitrarily Sized Signals – Most transforms can be applied to a signal or image of any size, and are not restricted to sample sizes divisible by integer powers of 2.
- Variety of Boundary Conditions – Boundary-treatment rules and boundary conditions accommodated in S+Wavelets include periodic, reflection, zero, polynomial extension, and internal wavelets.
- Wavelet Matrix Filter Operations – Matrix filter operations can be created for wavelet transforms. This is useful for education and research.

This work was done by Andrew Bruce and Hong-Ye Gao of MathSoft, Inc., for Stennis Space Center.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to

*STATSCI Division MathSoft
1700 Westlake Ave. North, Suite 500
Seattle, WA 98109*

Refer to SSC-00076, volume and number of this NASA Tech Briefs issue, and the page number.

Automated Generation of Reports of Mars Rover Operations

NASA's Jet Propulsion Laboratory, Pasadena, California

A document describes a system for the automated generation of reports of operations of a robotic exploratory vehicle (rover) on Mars. The automated report-generation system supplants a predominantly manual system, thereby making more information available in less time and reducing the probability of data-entry errors. The automated report-generation system has been incorporated

into the Web Interface for Telescience, WITS, and utilizes information in the WITS database. (Described in several prior NASA Tech Briefs articles, the WITS is an Internet-based software system that enables geographically dispersed scientists and engineers to monitor and command a rover.)

This work was done by Paul Backes and Jeffrey Norris of Caltech for NASA's Jet

Propulsion Laboratory. To obtain a copy of the document, "Automated Rover Sequence Report Generation," access the Technical Support Package (TSP) **free on-line at www.nasatech.com** under the Information Sciences category.

This software is available for commercial licensing. Please contact Don Hart of the California Institute of Technology at (818) 393-3425. Refer to NPO-21123.

ONE COMPONENT THERMALLY CONDUCTIVE SILICONE ADHESIVE/SEALANT

MASTER SIL 705TC

- Exceptionally high thermal conductivity
- Outstanding electrical insulation
- Service up to 400°F
- No mixing - one part system
- Room temperature cure
- Non-corrosive
- Excellent adhesion to different substrates
- Resists severe shock, vibration and

www.masterbond.com

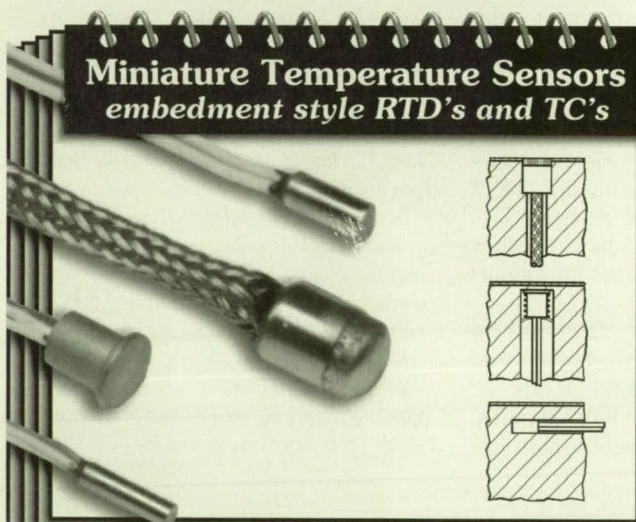


Master Bond Inc.
Adhesives, Sealants & Coatings

154 Hobart St., Hackensack, NJ 07601
TEL: 201-343-8983 FAX: 201-343-2132

For More Information Circle No. 442

Miniature Temperature Sensors embedment style RTD's and TC's



Metal encased RTD's and thermocouples as small as 0.3" x 0.08" ϕ (7.6 x 2 mm ϕ) • Rugged construction with Teflon insulated wires or stainless steel braided cable • Spring-loading option

Monitor bearing condition — embed beneath babbitt layer for continuous sensing • Monitor & control machinery • Ideal where rugged probe style sensor is required in restricted space

MINCO

Minco Products, Inc.

7300 Commerce Lane / Minneapolis, MN 55432-3177 U.S.A.
Tel: (763) 571-3121 / Fax: (763) 571-0927 / www.minco.com

New^{on} WEB

Free CAD Models

BAND-IT, Denver, CO, offers downloadable 2D and 3D models of more than 700 products from their Web site. 3D IGES models customized for 27 different systems, 3D STEP, and 2D DXF six-view layouts are available. The company manufactures and supplies stainless steel clamping, fastening, and identification systems. www.band-it-idex.com

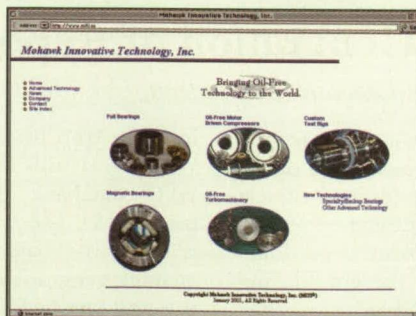
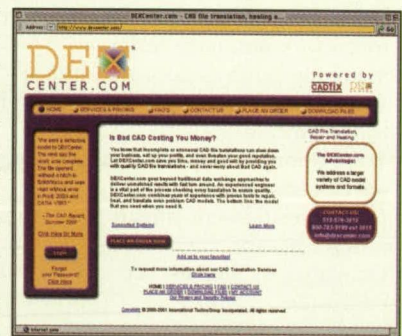


Electronic Enclosures

Electronic engineers can design, spec, view, price, and printout information on electronic enclosures via a new Web site from Equipto Electronics Corp., Aurora, IL. The site includes technical drawings, and a form that provides an instant parts list and prices on any electronic cabinet. The site also can be used to establish bills of materials and determine budgets. www.equiptoelec.com

CAD Model Repair

International TechneGroup, Milford, OH, has introduced DEXCenter.com™, an on-line service for CAD model repair, healing, and translation. It provides translation between systems and formats such as I-DEAS, UGS, Pro/ENGINEER, CATIA, Parasolid, IGES, STEP, and STL. Other tools available through the site include CADfix™ for model healing and repair, and CAD/IQ™, a model quality, interoperability, and six sigma testing tool. www.dexcenter.com



Machinery Bearings

Mohawk Innovative Technology, Albany, NY, has redesigned its Web site to include more information on the company's product development and technology capabilities. The company integrates its oil-free bearings into high-speed rotating machinery such as gas turbine engines and compressors. Also described on the site are compliant foil bearings and magnetic bearings. www.miti.cc

New on DISK

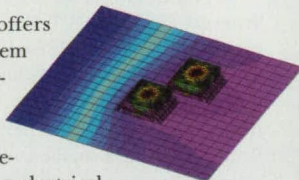
3D Simulation

ShapeSnatcher 3.0 from Eyetronics, Los Angeles, CA, is an integrated software package that creates high-resolution 3D models from 2D photographs. The package contains ShapeSnatcher 3.0, ShapeMatcher 2.0, ShapeReducer 3.0, Mapping Tools v2.0, and Xtrusion v2.0. ShapeSnatcher transforms a slide projector and digital camera into a 3D scanning and modeling system. The package features a built-in absolute scale in the calibration file, automatic reading of associated texture files, an "undo" function, automatic checking for OpenGL-compatible graphics cards, and a high-resolution texture map that maintains the original image size and maps onto the reduced-sized model. **Circle No. 727**



Thermal Analysis

Harvard Thermal, Harvard, MA, offers Version 6 of the Thermal Analysis System (TAS) thermal modeling software featuring SyncroMesh™, which allows users to create an interface between different parts of a model without having the element mesh agree. A detailed model of an electrical component can be placed on a coarse representation of the board and solved for temperatures. It can then be moved or duplicated, and then resolved without modifications. The system also includes two-button automeshing, vector-based heat loads, and heat flux contour plots. **Circle No. 728**



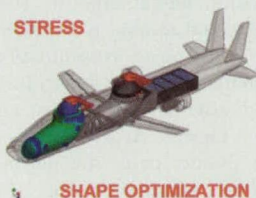
Technical Plotting

Amtec Engineering, Bellevue, WA, has announced Tecplot® Version 9.0 technical plotting software with 2D and 3D capabilities for visualizing technical data from analyses, simulations, and experiments. It uses OpenGL® to interactively visualize, explore, analyze, and virtually "fly" through large 2D and 3D data sets consisting of millions of data points. It can load and plot data organized in a variety of grid structures that are used in computer programs to simulate physics like fluid dynamics, electromagnetics, and heat transfer. **Circle No. 730**



Simulation and Analysis

ANSYS, Canonsburg, PA, offers DesignSpace® Version 6.0 up-front simulation software for confirming design assumptions and predicting product performance early in the design process. It features parametric simulation, thin sheet-metal capability, advanced non-linear contact, fatigue, and meshing controls. Users can view CAD parameters in DesignSpace and select those they wish to change. Those parameters, as well as material properties and loads, are assembled into a scenario table, and the software solves the scenarios and provides a "what-if" results summary. Productivity enhancements include an oversized model viewing window, interactive results displays, context-sensitive dialog boxes, customizable wizards, and a simulation "details" window. **Circle No. 731**



Synchronize to GPS



- Accurate GPS Satellite Clocks
- Synchronize Computers Precisely
- IRIG Time Code Input/Output
- Generate Pulse Rates

www.true-time.com

800.328.1230



TRUETIME

For More Information Circle No. 446

Rubber Edge Trim

Call for
FREE
samples

3M™ Acrylic Foam Tape Available.

GOT TRIM?

TRIM-LOK's highly flexible trims and seals provide noise reduction and superior edge protection.

TOLL FREE

1-888-TRIMLOK

874-6565

E-mail: info@trimlok.com
www.trimlok.com

TRIM-LOK® INC.
 Buena Park, CA

FOR CUSTOM EXTRUSIONS **RTP**

Leader of flexible plastics and rubber extrusions for over 25 years.

Now Available!
CUT-TO-LENGTH
 Selected items
 50 ft.
 minimum.

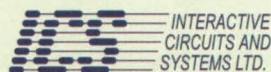
P48

Record Sensor Signals at 50MB/s with our Portable daqPC

Up to 128 channels



An 'Open Architecture' PC that
Acquires, Archives and Networks
Analog Sensor Signals in Real-Time



Nothing Else Comes Close

info@ics-ltd.com

www.ics-ltd.com

For More Information Circle No. 444

Just in time for summer... NASA T-shirts

Official red and
blue NASA vector
logo on quality
white cotton shirt.



Rush me ___ NASA T-shirts @ \$13.95 each. (Add \$5.00 to order for shipping. NY residents add sales tax.) Size(s):

Adult: ___ M ___ L ___ XL

Youth: ___ S ___ M ___ L

Total enclosed: \$ _____

☐ Check (payable to ABP International)☐ Credit Card: ☐ VISA ☐ Mastercard ☐ AmEx

Card No. _____

Exp. Date _____

Signature _____

Name _____

Company _____

Address _____

City/ST/Zip _____

Phone No. _____

E-mail _____

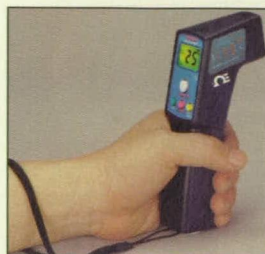
Fax to: (212) 986-7864 or mail to: ABP Intl., 317 Madison Ave.,
#1900, New York, NY 10017.

Order online: www.nasatech.com/store

New on the MARKET

Infrared Thermometer

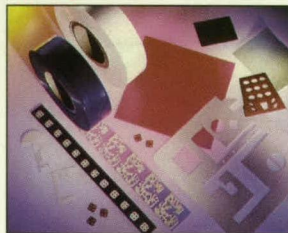
The OS540 portable infrared thermometer from OMEGA Engineering, Stamford, CT, is designed for non-contact temperature measurement applications, including diesel and fleet maintenance, electrical, HVAC/R automotive, in-process temperature measurement, and plastics molding. Features include circle or dot laser sighting, 9-volt battery, response time of 500 ms, and a temperature range from -20 to 420° C. It also offers resolution of 1°C/1°F and spectral response of 6-14 mm. **Circle No. 721**



Document Solutions

Xerox Engineering Systems, Stamford, CT, has introduced the Synergix 8825 DS, 8830 DS, and 8855 DS printers, each of which combines with the Synergix Scan System to create integrated solutions. All Synergix systems are modular, scaleable, and upgradeable for CAD, commercial reprographics, engineering departments, architectural firms, construction, utilities, and manufacturing. The Synergix Scan System processes smaller, lower resolution documents and automatically adjusts image quality. Features include background suppression, thick document handling, a flat document stacker that retains the order of document sets, batch mode, 256 grayscale conversion from full-color originals, and factory-aligned sensors that remain permanently aligned and require no manual recalibration. **Circle No. 725**

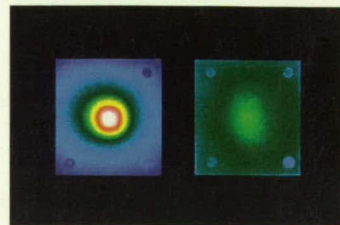
Epoxy Film



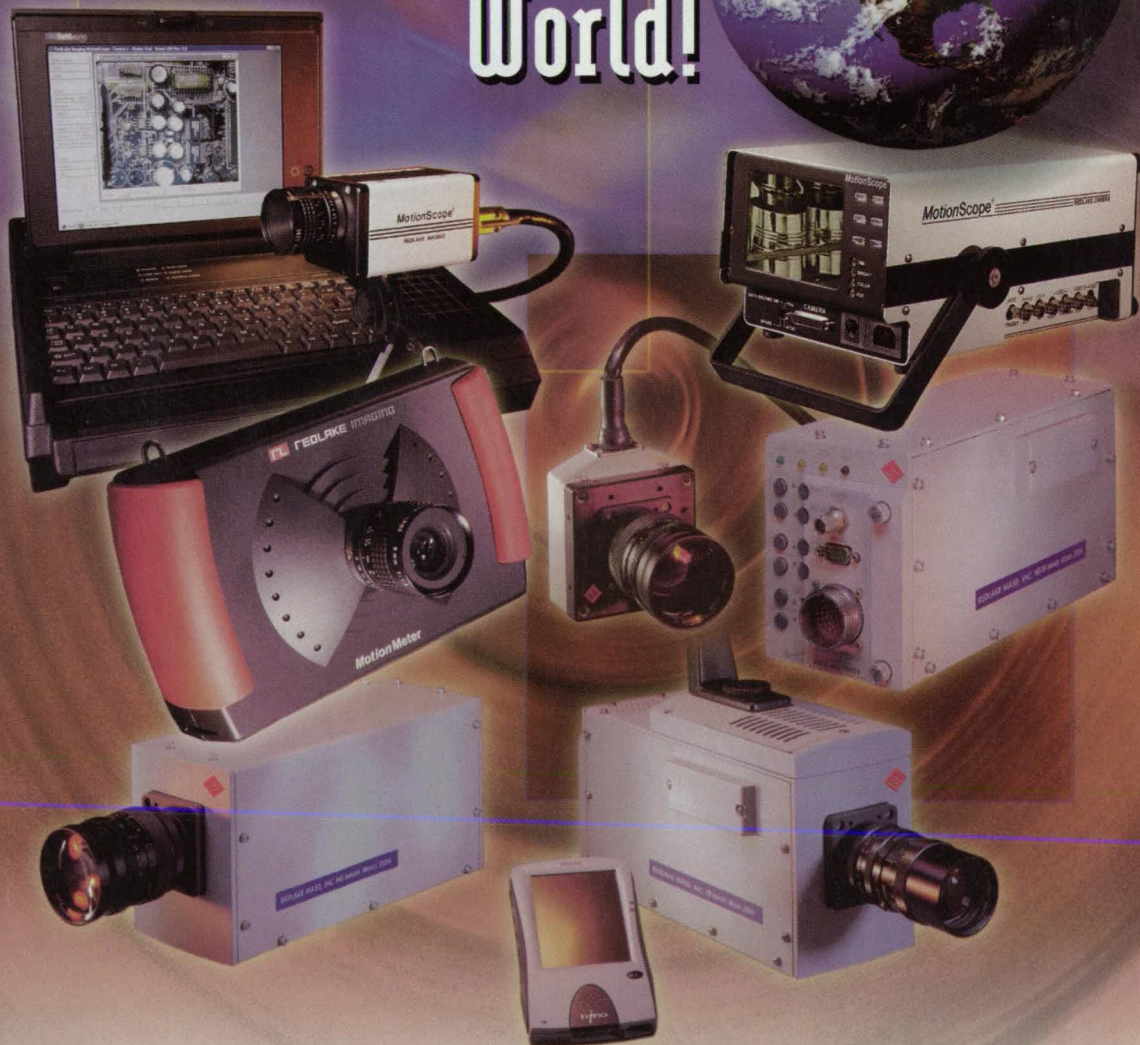
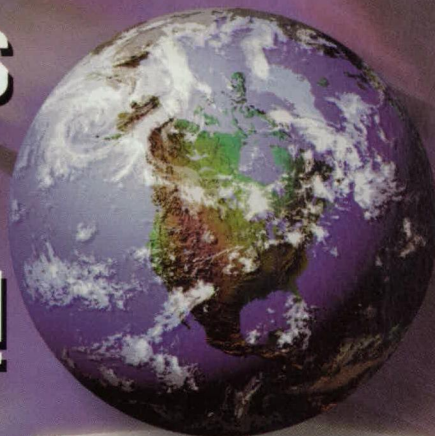
National Starch and Chemical, Bridgewater, NJ, offers PF2010 silver-filled epoxy film, an unsupported epoxy adhesive that provides thin, uniform bond lines with electrical and thermal properties. Typical properties include an aluminum-to-aluminum lap shear of over 2,400 psi, thermal conductivity at 121°C of 3.5 W/m²K, and volume resistivity of 0.0002 ohm-cm. It has a room-temperature work life of 90 days, and a long shelf-life when stored frozen. The film is available in sheet, tape, or die-cut pieces for specific bond lines. **Circle No. 722**

Thermally Conductive Polymer

CoolPoly® thermally conductive polymers from Cool Polymers®, Warwick, RI, is an alternative to metals, ceramics, and non-thermally conductive plastics. The polymers are suitable for use in applications such as industrial equipment, lighting, electronics, power electronics, medical, and automotive. The injection-molded polymer can replace metal and ceramic parts, offering lower weight, molded-in functionality and parts consolidation, elimination of post-machining and assembly operations, and heat transfer. As a replacement for plastics parts, the polymer offers elimination of "hot spots," effective heat transfer, and low coefficient of thermal expansion. **Circle No. 724**



We Have More Ways to Slow Down Your World!



Redlake high-speed cameras provide super slow motion images allowing you to see, measure and understand events that are too fast for the eye to perceive.



REDLAKE MASD, INC

1-800-462-4307

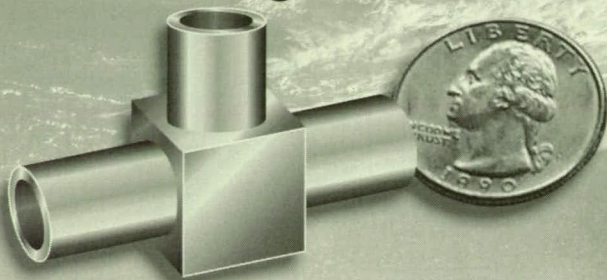
Phone: (858) 481-8182
FAX: (858) 792-3179
E-mail: sales@redlake.com



For More Information Circle No. 555

GP:50 Series 7900 Miniature Pressure Transducer

Under 55 grams mass!



WHATEVER
IT TAKES!

- Smallest Space Pressure Transducer Available
- Digitally Corrected to 0.15% Error Band
- RS485 or I²C Digital Output, Trio Option
- Radiation Hardened to 100K Rads

**CALL OR FAX FOR MORE INFORMATION
ON ALL OUR SERVICES AND PRODUCTS**

GP:50
AEROSPACE DIV.

2770 Long Road, Grand Island, NY 14072
Ph: 716-773-9300 • Fax: 716-773-5019
E-Mail: sales@gp50.com
Website: www.gp50.com

For More Information Circle No. 427

Is It Time To Renew Your NASA Tech Briefs Subscription?

Above your name on the mailing label there is an 11-digit number, a space followed by the letters "NB," and then a four-digit code. The first two digits of this code represent the year you last renewed your subscription. If this date is any earlier than "01," it is time to update your subscription *before it lapses*.

Take a moment today to renew at:

www.nasatech.com/subscribe

Reading someone else's copy?

Start your own subscription by completing the fast and easy online qualification form.

New LITERATURE



RF and Microwave Products

Giga-tronics, San Ramon, CA, has issued a catalog of microwave synthesizers, power meters, RF signal generators, and VXI instruments. The company designs, manufactures, and markets a line of RF and microwave instruments with applications in wireless communications, satellite transmission, aircraft navigation, and electronic defense. A sensor selection chart matches products to exact measurement requirements. **Circle No. 710**

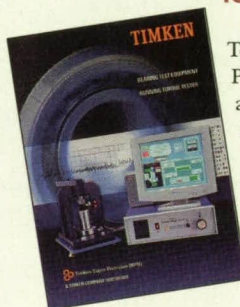
Thermoplastic Parts

RTP, Winona, MN, offers a technical brief describing physical property enhancements and the cost savings associated with compounds containing DuPont Fluoroguard® perfluoropolyether (PFPE) synthetic oil. The compounds eliminate "plate-out" associated with PTFE and increase throughput. Physical property enhancements include improved wear resistance, fatigue resistance, and minimized scratches or marring. **Circle No. 711**



Torque Tester

A brochure describing the RT2C-E Running Torque Tester is available from Timken Super Precision, Keene, NH. The tester determines the actual running torque inherent to a rotating system. A user can diagnose problems in existing bearing equipment or identify problems prior to use. Problems such as retainer hang-up, ball or race surface problems, contamination, internal geometry, and structural defects can be determined on a single bearing or a group of bearings through sampling. **Circle No. 712**



Contract Manufacturing

United for Excellence (UFE), Stillwater, MN, offers a brochure describing its product engineering, injection molding, mold manufacturing, and contract manufacturing services. These capabilities are for the design, development, and production of precision components or complete products. The services can be used individually or as part of an integrated program from design to final assembly. **Circle No. 713**



Standoff Fasteners

A four-page bulletin from PEM Fastening Systems, Danboro, PA, profiles PEM® SNAP-TOP® all-metal standoffs designed to attach and space PC boards and subassemblies without using screws or other threaded fastening hardware. Upon installation, the fasteners utilize a spring action to hold PC boards and subassemblies, while allowing for attachment and removal of boards or panels with snap-on/snap-off action. **Circle No. 715**

Advertisers Index

Advertisers listed in bold-face type also have banner ads on the *NASA Tech Briefs* web site this month. Visit www.nasatech.com

Company	Web Site	Circle Number	Page
Aero Tec Laboratories Inc.	www.atlinc.com	583	62
Alfa Aesar, a Johnson Matthey Company	www.alfa.com	612	63
Algor, Inc.	www.simulatemems.algor.com, www.etchlearning.com, www.algor.com, www.mems6.algor.com	595, 596, 609, 617	7, 51, 63, 64
Amacoil, Inc.	www.amacoil.com	607	63
American Magnetics, Inc.	www.americanmagnetics.com	602	63
Amtec Engineering, Inc.	www.amtec.com	543	13
Aremco Products, Inc.	www.aremco.com	619	64
Astro-Med, Inc.	www.astro-med.com/de16	525	2
ATI Industrial Automation	www.ati-ia.com	565	COV IV
Autodesk, Inc.	www.autodesk.com/sub	517	9
Beswick Engineering Co., Inc.	www.beswick.com	618	64
Ciprico	www.ciprico.com	416	61
Coherent, Auburn Group	http://catalog.coherentinc.com/II.html	486	5a
Comsol, Inc.	www.femlab.com/ient , www.comsol.com		24A-B
Cornell Dubilier	www.cornell-dubilier.com	487	46
Cosmos™	http://nasa.cosmosm.com	545	23
Crossbow Technology Inc.	www.xbow.com	405	40
Cutting Edge Optronics, Inc.	www.ceolaser.com	453	8a
DATAQ Instruments	www.dataq.com/nlit		64
Deschner Corporation	www.deschner.com	654	4b
Digi-Key Corporation	www.digi-key.com	516	3
DYADEM International Ltd.	www.fmeasoftware.com	608	63
Emhart, a Black & Decker Company	www.emhart.com	403, 567	20, 21
Endevco	www.endevco.com/4c2t	401	8
Engineering Design Team, Inc.	www.edt.com	438	60
Epix	www.epixinc.com/nt	445	12a
Equotip Associates		449	56
ERDAS, Inc.	www.erdas.com/vgis	414	35
Gage Applied, Inc.	www.gage-applied.com/ad/nasa601.htm	425	54
Gordon Products, Incorporated	www.gordonproducts.com	430, 431	46
HD Systems	www.HDSL.net	655	5b
HID Corporation	www.HIDCorp.com	415	39
Hunter Products Inc.	www.hunterproducts.com	613	64
Indigo Systems	www.indigosystems.com/lsr-ptb/	485	3a
Inecom, Inc.	www.InventorsInsider.com	615	64
Innovative Integration	www.innovative-dsp.com	441	61
Interactive Circuits and Systems Ltd.	www.ics-ltd.com	444	68
IOtech, Inc.	www.iotech.com	620	64
Kaman Instrumentation Operations	www.kamansensors.com	411	28
Keithley Instruments, Inc.	www.keithley.com	553, 614	43, 64
Lake Shore Cryotronics, Inc.	www.lakeshore.com	434	49
Lumex, Inc.	www.lumex.com	604	63
Master Bond Inc.	www.masterbond.com	424, 442	48, 66
The MathWorks, Inc.	www.mathworks.com/nttm	512	17
Matrox Imaging	www.matrox.com/imaging/ads/cam/nt	454	9a

Company	Web Site	Circle Number	Page
Micro-Drives	www.micro-drives.com		8b
Micro-Epsilon	www.micro-epsilon.com	410	26
Micro Mo Electronics	www.micromo.com	651, 652	8b
Microsoft	www.microsoft.com/project	520	4-5
Minalex		601	63
Minco Products, Inc.	www.minco.com	443	66
MSC Software	www.mscsoftware.com/marc	550	COV III
National Instruments Corporation	www.ni.com/info, www.ni.com/info/showcase, www.ni.com/info/instrupedia	508, 426, 451, 603, 653, 656	COV II, 55, 4a, 63, 3b, 7b
Newark Electronics	www.newark.com	558	45
Omega Engineering, Inc.	www.omega.com	501-505, 623	1, 64
Orand Systems Inc.	www.orandsystems.com	622	64
Parker Hannifin Corp., Daedal Division	www.phdaedal.com/tblf	610	63
Patton & Patton Software Corp.	www.patton-patton.com	621	64
PEM Fastening Systems, a Penn Engineering Company	www.pemnet.com	418	44
Photon, Inc.	www.photon-inc.com	450	7a
Pittman - A Penn Engineering Company	www.pittmannet.com	606	63
PocketCAD	www.pocketcad.com	572	15
Presray Corporation	www.presray.com	413	34
Quatech, Inc.	www.quatech.com	419	47
RadioShack.com	www.radioshack.com/b2b	592	19
Redlake MASD, Inc.	www.redlake.com	555	69
Research Systems, Inc.	www.researchsystems.com/ntb	412	30
RGB Spectrum	www.rgb.com	402	10
Silicon Recognition, Inc.	www.silirec.com	409	24
Smalley Steel Ring Company	www.smalley.com	611	63
Sony Precision Technology America	www.sonypt.com	527	27
Specialty Polymer Products	www.polymersealing.com	423	22
Stanford Research Systems	www.thinkSRS.com	586	41
StellarNet Inc.	www.stellarnet-inc.com	498	13a
StockerYale Canada Inc.	www.lasiris.com	455	11a
StorCase Technology, A Kingston Technology Company	www.storcase.com	546, 605	11, 63
Sunnex, Inc.	www.sunnexonline.com	616	64
Synrad, Inc.	www.synrad.com	561	37
Tescom Corporation	www.tescom.com	406	18
Thermo Laser Science	www.laserscience.com	484	1a
Trim-Lok Inc.	www.trimlok.com	447	67
Triton Systems, Inc.	www.tritonsystems.com	440	59
TrueTime	www.true-time.com	446	67
TSI Incorporated, Flowmeter Products	http://flowmeters.tsi.com	437	57
United Electronic Industries	www.PowerDAQ.com	404	22
Velmex Inc.	www.velmex.com/b	422, 582	48, 62
Yet2.com	www.yet2.com, www.nasatech.com/techsearch		29, 31
YSI	www.ysi.com	436	58

Ride-along enclosed in versions 1, 2, 3, & 4

NASA Tech Briefs, ISSN 0145-319X, USPS 750-070, copyright ©2001 in U.S. is published monthly by Associated Business Publications Co., Ltd., 317 Madison Ave., New York, NY 10017-5391. The copyright information does not include the (U.S. rights to) individual tech briefs that are supplied by NASA. Editorial, sales, production, and circulation offices at 317 Madison Ave., New York, NY 10017-5391. Subscription for non-qualified subscribers in the U.S., Panama Canal Zone, and Puerto Rico, \$75.00 for 1 year; \$135 for 2 years. Single copies \$5.00. Foreign subscriptions one-year U.S. Funds \$195.00.

Remit by check, draft, postal, express orders or VISA, MasterCard, and American Express. Other remittances at sender's risk. Address all communications for subscriptions or circulation to *NASA Tech Briefs*, 317 Madison Ave., New York, NY 10017-5391. Periodicals postage paid at New York, NY and additional mailing offices.

POSTMASTER: Send address changes to *NASA Tech Briefs*, PO Box 10523, Riverton, NJ 08076-9023.

FREE INFORMATION REQUEST FORM

For quickest service:

Fax this form to (413) 637-4343

Use the online reader service center at www.nasatech.com (click on "Get More Information...FAST")

Or mail your completed form to
NASA Tech Briefs,
PO Box 5077, Pittsfield, MA 01203-9109.

Name: _____

Company: _____

Address: _____

City/St/Zip: _____

Phone: _____

Fax: _____

e-mail: _____

Please tell us below how *NASA Tech Briefs* has helped you solve a problem or been applied to your business/product line.

Do you currently receive *NASA Tech Briefs*? ☐ Yes ☐ No

If no, would you like to receive *NASA Tech Briefs*? ☐ Yes ☐ No

Circle the numbers below to receive more information about products and services featured in this issue.

401	402	403	404	405	406	407	408	409	410
411	412	413	414	415	416	417	418	419	420
421	422	423	424	425	426	427	428	429	430
431	432	433	434	435	436	437	438	439	440
441	442	443	444	445	446	447	448	449	450
451	452	453	454	455	456	457	458	459	460
461	462	463	464	465	466	467	468	469	470
471	472	473	474	475	476	477	478	479	480
481	482	483	484	485	486	487	488	489	490
491	492	493	494	495	496	497	498	499	500
501	502	503	504	505	506	507	508	509	510
511	512	513	514	515	516	517	518	519	520
521	522	523	524	525	526	527	528	529	530
531	532	533	534	535	536	537	538	539	540
541	542	543	544	545	546	547	548	549	550
551	552	553	554	555	556	557	558	559	560
561	562	563	564	565	566	567	568	569	570
571	572	573	574	575	576	577	578	579	580
581	582	583	584	585	586	587	588	589	590
591	592	593	594	595	596	597	598	599	600
601	602	603	604	605	606	607	608	609	610
611	612	613	614	615	616	617	618	619	620
621	622	623	624	625	626	627	628	629	630
631	632	633	634	635	636	637	638	639	640
641	642	643	644	645	646	647	648	649	650
651	652	653	654	655	656	657	658	659	660
661	662	663	664	665	666	667	668	669	670
671	672	673	674	675	676	677	678	679	680
681	682	683	684	685	686	687	688	689	690
691	692	693	694	695	696	697	698	699	700
701	702	703	704	705	706	707	708	709	710
711	712	713	714	715	716	717	718	719	720
721	722	723	724	725	726	727	728	729	730
731	732	733	734	735	736	737	738	739	740
741	742	743	744	745	746	747	748	749	750
751	752	753	754	755	756	757	758	759	760
761	762	763	764	765	766	767	768	769	770
771	772	773	774	775	776	777	778	779	780
781	782	783	784	785	786	787	788	789	790
791	792	793	794	795	796	797	798	799	800
801	802	803	804	805	806	807	808	809	810
811	812	813	814	815	816	817	818	819	820
821	822	823	824	825	826	827	828	829	830
831	832	833	834	835	836	837	838	839	840

ARE YOU AN INSIDER?

Subscribe today to receive the INSIDER, a FREE e-mail newsletter from *NASA Tech Briefs*. The INSIDER features exclusive previews of upcoming articles...late-breaking NASA and industry news...hot products and design ideas...links to online resources...and much more.

☐ I want to be an INSIDER. Send my newsletter to the following e-mail address:

 Name _____

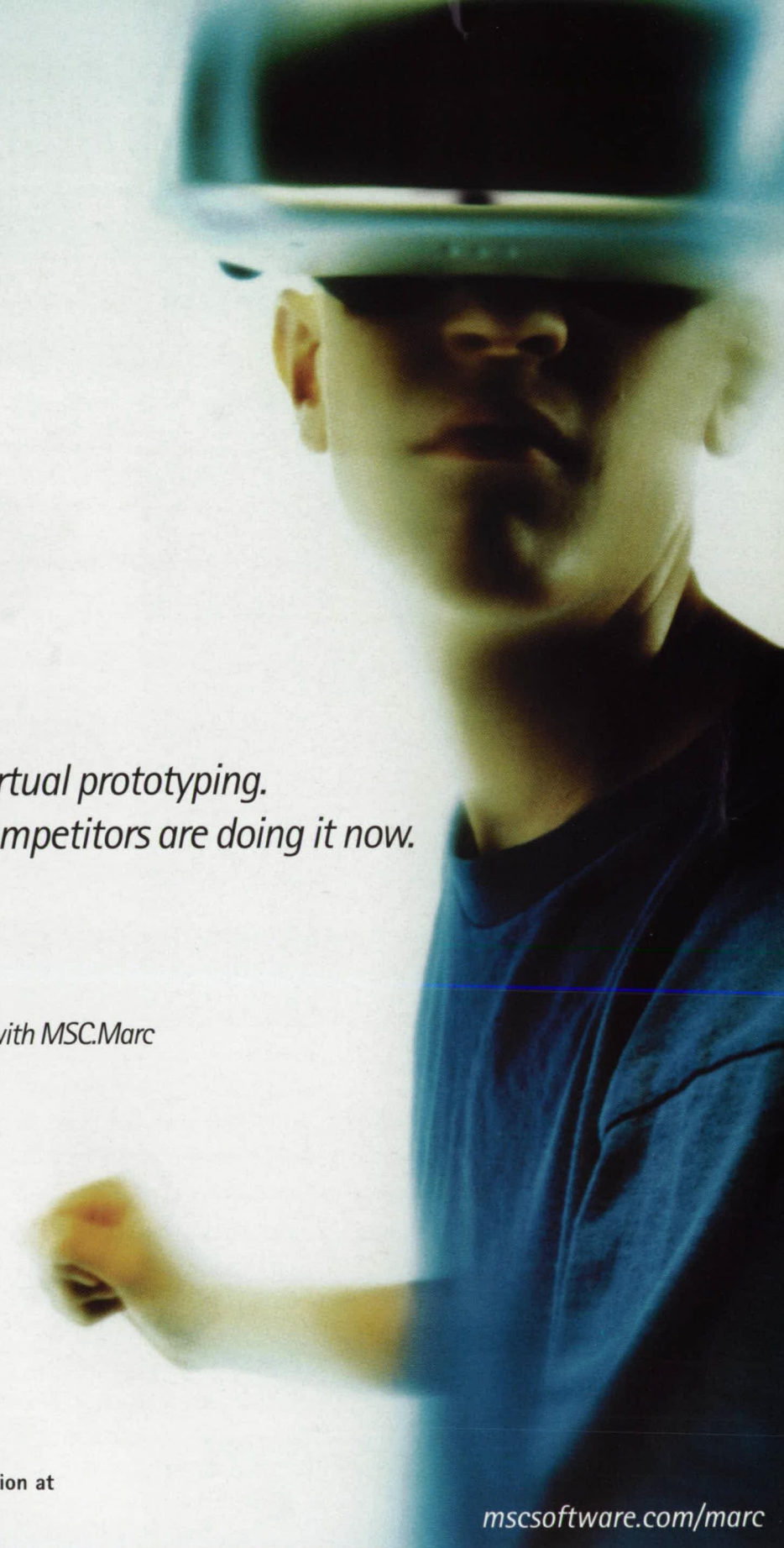
 Company _____

I also want to receive special-focus e-newsletters on the following technology topics: (check all that apply)

- | | |
|----------------------------------|--|
| <input type="checkbox"/> CAD/CAE | <input type="checkbox"/> Fiber Optics/Communications |
| <input type="checkbox"/> Lasers | <input type="checkbox"/> Test & Measurement |
| <input type="checkbox"/> Optics | <input type="checkbox"/> Imaging/Cameras |
| <input type="checkbox"/> Sensors | |

For fastest service, sign up online at www.nasatech.com. Look for this button at the top of the home page ▶ ▶ ▶ ▶ ▶ ▶ ▶ ▶

**FREE
NEWSLETTER**



*some day, you'll use virtual prototyping.
unfortunately, your competitors are doing it now.*

Eliminate physical prototyping with MSC.Marc

While you're making prototypes, MSC.Marc users are making progress. MSC.Marc's unparalleled nonlinear FEA capabilities allow them to iterate and perfect their design virtually, for unprecedented speed to market. Proven by 30 years of use in over 5000 customer installations, MSC.Marc scales from small Intel workstations to distributed computing and supercomputers.

Begin catching up with the competition at mscsoftware.com/marc today!

mscsoftware.com/marc

MSC.visualNastran
Simulation, motion, and
stress online—anywhere.

MSC.visualNastran Desktop
Motion and stress simulation
on your desktop.

MSC.visualNastran Professional
Powerful analysis on
the Windows platform.

MSC.visualNastran Enterprise
World's leading mission-critical
analysis software.

DO IMPOSSIBLE THINGS WITH MSC.VISUALNASTRAN PRODUCTS

MSC.Marc

MSC SOFTWARE
SIMULATING REALITY

For More Information Circle No. 550

Six-axis Force/Torque Sensors

Strong Transducers With Low-Noise Outputs Measuring F_x , F_y , F_z , T_x , T_y , T_z .

**NEW PCI, cPCI
& PCMCIA Interfaces**



Shown are ATI six-axis transducers from 17mm dia. to 330 mm dia.

ATI manufactures a variety of extremely robust six-axis Force/Torque (F/T) sensors that provide low-noise, high-resolution signals with output speeds of up to 10kHz and factors of safety up to 27 times measurement range. Since 1983, ATI has provided thousands of customers with F/T's ranging from the smallest six-axis sensor in the world (17 mm diameter) to sensors measuring thousands of pounds. The F/T can provide data via voltage outputs, RS-232 serial or interface with either ISA, PCI, PCMCIA or cPCI buses. ATI is developing interfaces to Firewire, VXI, USB, DeviceNet and Ethernet. The F/T can also interface with analog data acquisition systems (seven channels required).

For more information, contact Milton Gore at mgore@ati-ia.com or extension 132.

"I highly recommend ATI's force/torque transducers to anyone who needs a reliable, pre-calibrated, easily programmable transducer. It is a truly versatile plug-and-play system."

Prof. Francisco Valero-Cuevas
Neuromuscular Biomechanics Laboratory
Sibley School of Mechanical and Aerospace Engineering
Cornell University

"Because of their off-the-shelf solutions for miniature force and torque sensing, we were able to go from concept to working prototype in months instead of years."

Patrick Jensen, Ph.D., Assistant Professor of Ophthalmology
Johns Hopkins University

"The force/torque systems from ATI are ideal in our study of human grip force coordination and production. They are as close to a turn-key system that we have found."

Professor Jay L. Alberts, Ph.D.
Dept. of Health and Performance Sciences
Georgia Institute of Technology

Our Products Also Include:

- | | |
|---------------------|-------------------------------------|
| Quick-Change | Robotic Tool Changer |
| Protector | Robotic Crash Protection Device |
| Speedeburr | Robotic Deburring Tool |
| Compensator | Automated Assembly Alignment Device |

**ATI INDUSTRIAL
AUTOMATION**
ISO 9001 Registered

Engineered Products for Manufacturing Productivity

Pinnacle Park, 1031 Goodworth Drive, Apex, North Carolina 27502 USA
Tel: +1.919.772.0115 • Fax: +1.919.772.8259
Email: info@ati-ia.com • www.ati-ia.com

For More Information Circle No. 565